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REPORT NO. 10

MILITARY SPACE PROJECTS

MARCH - APRIL - MAY 1960

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OFFICE OF THE DIRECTOR
OF
DEFENSE RESEARCH AND ENGINEERING

Approved J.B. Macauley for
Herbert F. York,
Director

DEPARTMENT OF DEFENSE WASHINGTON 25, D.C.

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August 16, 1960

MEMORANDUM FOR THE SECRETARY OF DEFENSE

SUBJECT: Progress Report on Military Space Projects for March, April, and May 1960

Progress of the Military Space Projects during March, April, and May 1960 is reviewed in the attached summary.

Noteworthy events occurring subsequently to date are summarized in your letter of transmittal to the President, which I recommend that you sign.

J.B. Macauley
for HERBERT F. YORK

Inclosure - 1
Ltr to President
w/summary report

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August 18, 1960

Dear Mr. President:

A summary of progress on the Military Space Projects during March, April, and May 1960 is attached.

During the subsequent period to date, the following events of interest have occurred.

DISCOVERER XIII was launched from Vandenberg Air Force Base and successfully placed into orbit on 10 August 1960. On 11 August, a highly-instrumented data capsule was ejected from the satellite on its 17th orbital pass and was retrieved from the water in the Pacific Ocean recovery area by a helicopter from an on-station recovery ship. Tracking stations reported continuous bearings on the capsule during its half-hour descent and aircraft reported visual sighting of the capsule in the water. Cloud cover apparently prevented airborne recovery. This is our first successful recovery of a data capsule from an orbiting satellite.

DISCOVERER XII was launched from Vandenberg Air Force Base on 29 June. The powered flight trajectories of the THOR booster and AGENA second-stage vehicles were normal. A malfunction, however, apparently occurred in the horizon scanner which resulted in a pitch down attitude and caused the satellite vehicle to re-enter the atmosphere.

The SAMOS and MIDAS Projects are, in general, on schedule and are progressing satisfactorily.

TRANSIT 2A was launched into orbit from the Atlantic Missile Range on 22 June using the THOR-ABLE STAR launching vehicle combination. The TRANSIT 2A satellite carried a Naval Research Laboratory radiation satellite as a pick-a-back package. In-orbit separation of the two payloads was successfully accomplished. This is the first time that two satellite payloads have been placed into orbit by one launching vehicle. All experiments in the satellites are functioning properly and extremely useful data are being obtained for further development of the satellite navigational system.

With great respect, I am

Faithfully yours,

Signed
THOMAS S. GATES

Attachment

The President
The White House

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SUMMARY

DISCOVERER PROJECT (Research and Development Satellites)

DISCOVERER XI was launched from Vandenberg Air Force Base on 15 April. The powered flight trajectory of the THOR-AGENA launching vehicle and orbital injection were excellent. All program objectives were attained with the exception of capsule recovery. Successful recovery was prevented by capsule ejection on a higher than nominal re-entry trajectory. Intensive testing of recovery system components has been initiated to provide maximum probability of successful recovery on future flights.

All AGENA "A" vehicles and the first AGENA "B" vehicle were delivered during March.

The construction contract for the Vandenberg Air Force Base propellant storage and disposal facility was awarded in April with completion scheduled for September. The conversion of launch pad 5 at Vandenberg Air Force Base to AGENA "B" capability has been started.

SAMOS PROJECT (Reconnaissance Satellites)

[redacted]

MIDAS PROJECT (Very Early Warning Satellites)

The second MIDAS flight test vehicle was launched successfully from the Atlantic Missile Range on 24 May. Orbital performance was outstanding. A total of thirty minutes readout time was recorded during the first two passes.

Preliminary planning and design work was authorized in support of two additional MIDAS flights using THOR/AGENA vehicles obtained from the DISCOVERER Program.

A study is being made of the feasibility of extending MIDAS operational system capability to provide world-wide coverage.

Procurement has been authorized for a third Programmable Integrated Control Equipment (PICE) unit as part of the interim MIDAS equipment at the New Boston, New Hampshire tracking station. This unit will be similar to the PICE units at the Satellite Test Center and at Vandenberg Air Force Base.

Construction of the Vandenberg Air Force Base data acquisition and processing building was essentially complete in May and ready for installation of technical equipment.

TRANSIT PROJECT (Navigation Satellites)

TRANSIT 1B was launched into orbit on 13 April 1960 by a THOR-ABLE STAR vehicle from the Atlantic Missile Range. TRANSIT tracking operations and analysis of telemetered data indicate that the operation of all equipment is normal.

The third attempt to perform a TRANSIT-on-DISCOVERER experiment was successful in the launching of DISCOVERER XI satellite into orbit on 15 April. The TRANSIT equipment is performing well.

All seven TRANSIT receiving stations began tracking TRANSIT 1B satellite from the time of its launch. These stations also began tracking TRANSIT-on-DISCOVERER with the launch of DISCOVERER XI. The tracking stations have been giving excellent performance.

NOTUS PROJECT (Communications Satellites)

The two launchings for COURIER, the delayed repeater satellite, originally scheduled for 19 July and 1 September 1960 were rescheduled for 16 August and 4 October because of needed modifications in the second stage of the THOR-ABLE STAR launch vehicle.

Development and testing of the two COURIER satellite vehicles and of the equipment at the two ground stations at Puerto Rico and Fort Monmouth, New Jersey are proceeding satisfactorily on schedule.

The three previous programs, STEER, TACKLE and DECREE, were modified into a single research and development program, ADVENT, for an instantaneous repeater satellite in a 24-hour synchronous (hovering) equatorial orbit.

The research and development phases and the determination of management responsibilities for ADVENT are undergoing study.

SHEPHERD PROJECT (Tracking Network)

The space surveillance (SPASUR) system operated continuously and successfully acquired, observed, monitored and collected data on all earth satellites within its range.

The National Space Surveillance Control Center (SPACETRACK) collated the data collected, computed satellite orbits, issued orbital predictions and catalogued all space objects reported.

Among the satellite observations was that of SPUTNIK IV launched by the Soviet Union on 15 May. On 18 May, the SPASUR network confirmed that an attempt had been made to change the orbit of SPUTNIK IV so that its payload would re-enter the earth's atmosphere. Because of some malfunction, velocity was added instead of subtracted, and eight pieces of the original SPUTNIK IV are in orbit. All of these objects have been tracked by the space surveillance network.

A centrally located 500 kw transmitter has been authorized that will fill the present detection gap between the two existing surveillance complexes.

CONTENTS

ILLUSTRATIONS

I. DISCOVERER PROJECT

(RESEARCH AND DEVELOPMENT SATELLITES)

A. Project Objectives

1. General

Objective is to develop and test components for Military Space Technology Program.

The objectives of the DISCOVERER Satellite Project are to conduct research and development on components, equipment, instrumentation, propulsion, data processing, communications, capsule recovery and operating techniques all dealing with military space technology.

2. Specific

Project Objectives - Specific listing.

a. Flight test of the satellite vehicle airframe, propulsion, guidance and control systems, auxiliary power supply, and telemetry, tracking and command equipment.

b. Attaining satellite stabilization in orbit.

c. Obtaining satellite internal thermal environment data.

d. Testing of techniques for recovery of a capsule ejected from an orbiting satellite.

e. Testing of ground support equipment and development of personnel proficiency.

f. Conducting biomedical experiments with mice and small primates, including injection into orbit, re-entry and recovery.

B. Project Description

DISCOVERER Project consists of the launch of 29 satellite vehicles, possibly 35.

1. The DISCOVERER Project consists of design, development, and launch of 29 two-stage satellite vehicles. The first stage is the THOR IRBM and the second stage is the AGENA satellite vehicle. Each stage will be modified as the launching program progresses. Review is being given to the possibility of adding six additional flight test vehicles of the final version to the launching schedule.

Provides support for SAMOS, MIDAS, and other projects.

2. This flight test program will provide:

a. Research and component development in support of the SAMOS, MIDAS, and certain other projects using AGENA satellite vehicles.

b. Tests of the ground communications and tracking network developed for the above projects.

c. Flight tests of the AGENA vehicle and subsystems.

C. Progress Review - March, April, May 1960

1. Flights

Successful DISCOVERER XI launch on 15 April.

a. DISCOVERER XI was launched from Vandenberg Air Force Base on 15 April. The countdown proceeded very smoothly despite high winds. Terminal countdown time was only 12 minutes, 45 seconds. Launch, first stage THOR performance, separation, AGENA ignition, and orbital injection were excellent. The resulting orbit had a perigee of 109.5 statute miles, an apogee of 380 statute miles, an eccentricity of 0.033 and an orbital period of 92.3 minutes.

Fifteen commands received and verified.

b. Acquisition was accomplished by every station on every pass. All fifteen commands were received and verified by the satellite. The horizon scanner, inertial reference package, and gas jet control system functioned extremely well, resulting in excellent satellite attitude stabilization. The satellite power supply, including the two advanced design static inverters, performed efficiently. The main batteries lasted through the 26th orbit.

Recovery capsule spin rockets may not have fired.

c. Telemetry data indicate that the recovery capsule was ejected on the 17th orbit as planned. The predicted re-entry trajectory did not occur. A good track of the capsule telemetry was obtained by the Kaena Point station. Capsule separation and retro-rocket firing were verified. However, spin rocket firing was not verified.

Intensive recovery system component test program is initiated.

d. The high re-entry trajectory of the recovery capsule has resulted in an intensive recovery system component test program. This program is designed to gather information from which corrections will be made to assure maximum probability of recovery on subsequent DISCOVERER flights.

DISCOVERER XI carried doppler beacon and optical tracking lights.

e. DISCOVERER XI was the first orbiting AGENA to carry the dual-frequency doppler beacon (Applied Physics Laboratory (APL)) and four optical tracking lights. Satisfactory tracking of both systems was achieved at stations in the United States and abroad. Sufficient data were received to indicate successful performance of the system. Although the APL beacon is being displaced by a portion of the diagnostic payload for the next DISCOVERER flight, the optical tracking lights will be operational. Subsequent AGENA "A" DISCOVERER vehicles will carry the complete system.

Increased telemetry of payload recovery sequence.

f. As part of the diagnostic program, a more complete "blossom" telemetry package is being installed to monitor the DISCOVERER XII capsule recovery sequence. This package will provide information on all phases of capsule ejection including retro, spin, and de-spin rocket operation and parachute deployment sequencing.

Holloman Air Force Base and Santa Cruz Test Base conduct recovery system test program.

g. Portions of the recovery system test program are being conducted at Santa Cruz Test Base and at Holloman Air Force Base. Spin rocket firings have been checked in a series of capsule drop tests at Santa Cruz. At Holloman, functional phases of the recovery system are being tested in a series of capsule drop tests from balloons.

Increased telemetry receiving stations provided for DISCOVERER XII flight.

h. A flight readiness date for the launch of DISCOVERER XII depends upon the installation of the diagnostic payload and the completion of the recovery system test program. Deployment of the recovery force is being revised for this flight. Telemetry receiver equipment is being installed on Christmas Island in the South Pacific to provide telemetry reception if the re-entry trajectory carries the capsule beyond the planned recovery range. Ground tracking stations having telemetry receiving equipment are located at Kodiak, Alaska, and Kaena Point, South Point and Barking Sands, Hawaii. Additional telemetry reception will be provided by five C-54 aircraft and three surface vessels. All phases of the DISCOVERER XII payload recovery sequence from ejection through parachute deployment will be transmitted.

2. Technical Status

a. Second Stage Vehicles

All AGENA "A" vehicles delivered.

(1) The final AGENA "A" vehicle for DISCOVERER Program was delivered to Vandenberg Air Force Base during March.

Three AGENA "B" vehicles complete hot firing tests.

(2) The first AGENA "B" vehicle (XIR-81 Ba-7 engine) was delivered to Santa Cruz Test Base on 1 March. The vehicle was installed in test stand 2 and hot firing tests have been conducted. Both this vehicle and the third AGENA "B" delivered from manufacturing have completed their hot firing tests and have been returned to the Systems Test Area for rework and a second systems check prior to Air Force acceptance. The second AGENA "B" vehicle is in storage following Air Force acceptance on 3 May.

Nozzle extension tests continue at Bell Aircraft and Arnold Engineering Development Center.

(3) Testing of nozzle extensions for the XIR-81 Ba-9 engine continued at Bell Aircraft and Arnold Engineering Development Center throughout the quarter. All tests of the 45:1 area ratio titanium nozzles have been successful. This nozzle has been released to production and will be used on flight vehicles. A test series was initiated on 6 May including starts and restarts at temperatures of plus 20 and minus 10 degrees Fahrenheit. Development of an uncooled nozzle which will provide a weight savings of five-to-ten pounds and simplify fabrication is being continued.

Thrust chamber erosion problem on XIR-81 Ba-9 engines.

(4) Acceptance tests of the XIR-81 Ba-9 engine at the contractor's facility revealed erosion of the thrust chamber throat. Corrective action to eliminate the erosion is underway and successful modifications are anticipated at an early date.

b. Beacons

Transistorized S-band beacon installed in AGENA "B" vehicle.

The manufacture of two transistorized S-band beacons was completed during March. One of the beacons will be used for type testing and the other will become the flight article for the first AGENA "B" flight. Type testing of the first beacon was completed during April and the first flight beacon was delivered to Lockheed Missiles and Space Division for installation in the AGENA "B" vehicle.

c. Biomedical Capsules

Delivery of test capsule (USE-77) is delayed until August.

Delivery of the test capsule (USE-77) to be used in the specialized biomedical environmental testing of Mark II flight components, has been delayed until August. Upon arrival, a series of vibration, centrifuge, and impact tests will be conducted to assure reliable flight operation.

d. Ground Support Equipment

One hundred pin umbilical system will be installed in DISCOVERER XVII.

(1) Replacement of the present 200 pin umbilical system with a 100 pin system will begin with the launch of DISCOVERER XVII. The new system also will provide increased reliability by permitting simplification of checkout procedures, and will reduce over-all manhour requirements.

New ground handling equipment delivered in April.

(2) A ground handling dolly adaptable for either AGENA "A" or "B" configurations was introduced in April. The AGENA vehicle will be mounted in the dolly during assembly and checkout. A new vehicle transporter for transfer of AGENA "B" vehicles between Lockheed Missiles and Space Division, Santa Cruz Test Base and Vandenberg Air Force Base also was placed in service in April.

AGENA "B" facilities checkout vehicle for use at Vandenberg Air Force Base completed.

(3) An AGENA "B" facilities checkout vehicle for use at Vandenberg Air Force Base was completed during April. This vehicle is capable of facilities checkout for the DISCOVERER, SAMOS, and MIDAS Programs.

3. Facilities

Modification of Hawaiian tracking station to support the TIROS project was completed on schedule.

a. Hawaiian Tracking Station

Modifications to the Hawaiian tracking station, in support of the NASA TIROS project were completed during March. Changeover time between programs was approximately 20 minutes.

b. Vandenberg Air Force Base

Vandenberg Air Force Base propellant storage and disposal facility construction contract awarded.

The construction contract for the Vandenberg Air Force Base propellant storage and disposal facility was awarded in April with completion scheduled for September. The conversion of launch pad 5 at Vandenberg Air Force Base to AGENA "B" capability has been started. All ground handling

GROUND SUPPORT FACILITIES

Facility	*Equipment **	*Flight Function*
Satellite Test Center	a	Over-all control, convert tracking stations data to obtain a predicted orbit and generate subsequent ephemerides issue acquisition data to tracking stations for subsequent passes, predict recovery area.
Vandenberg AFB	bcdefghijk	Launch, ascent and orbital tracking, telemetry reception, trajectory measurements including time to ignite second stage.
Point Mugu	bcdefghijkl	Ascent tracking and telemetry data reception, transmits command to ignite and shut down AGENA (via guidance computer).
Telemetry Ship (Pvt. Joe E. Mann)	df	Final stage ascent tracking and telemetry data reception.
Annette Island, Alaska (tracking station)		Activity at this station terminated 1 December 1959 due to fund limitations.
Cape Chiniak, Alaska (tracking station)	bdefghijk	Orbital tracking and telemetry data reception, including first pass acquisition, recovery capsule ejection and impact prediction.
Kaena Point, Oahu, Hawaii (tracking station)	bcdefghijk	Orbital tracking and telemetry data reception.
Hickam AFB Oahu, Hawaii		Over-all direction of capsule recovery operations.

* *Equipment*

a. 2 UNIVAC 1103-A digital computers
b. VERLORT (Modified Mod II) radar
c. TLM-18 self-tracking telemetering antenna
d. Tri-helix antenna
e. Doppler range detection equipment
f. Telemetry tape recording equipment
g. Telemetry decommutators for real time data presentation
h. Plot boards for radar and TLM-18 tracking data
i. Conversion equipment for teletype transmission of radar, TLM-18 and doppler tracking data in binary format
j. Acquisition programmer for pre-acquisition direction of antennas
k. Ground command to satellite transmission equipment
l. Guidance computer

Figure I - 1.

Conversion of Pad 5 at Vandenberg Air Force Base to provide AGENA "B" capability has started.

and service equipment necessary to make the change has been shipped to the site. Included is the new mast extension required to accommodate the greater length of the AGENA "B" vehicle. Changes also are being incorporated into the propellant loading system to permit two acid trucks to load propellant into the vehicle simultaneously.

D. Project History and Management

Project was established in 1958 under ARPA.

1. This project was established early in 1958 under direction of the Advanced Research Projects Agency (ARPA), with technical management assigned to Air Force Ballistic Missile Division (AFBMD). On 17 November 1959, program responsibility was transferred from ARPA to the Air Force by the Secretary of Defense. Prime contractor for the program is Lockheed Missiles and Space Division.

E. Project Features

1. General

General features of project.

a. Early launches confirmed vehicle flight and satellite orbit capabilities, developed system reliability, and established ground support, tracking and data acquisition requirements. Later in the program, biomedical and advanced engineering payloads will be flight tested to obtain support data for more advanced space systems programs. DISCOVERER vehicles are launched from Vandenberg Air Force Base, with overall operational control exercised by the Satellite Test Center, Palo Alto, California.

Listing of ground stations and flight tests.

b. Tracking and command functions are performed by the stations listed in Figure I-1. A history of DISCOVERER flights to the end of the reporting period is given in Figure I-2.

Description of launch trajectory orbital pattern, and recovery of capsule.

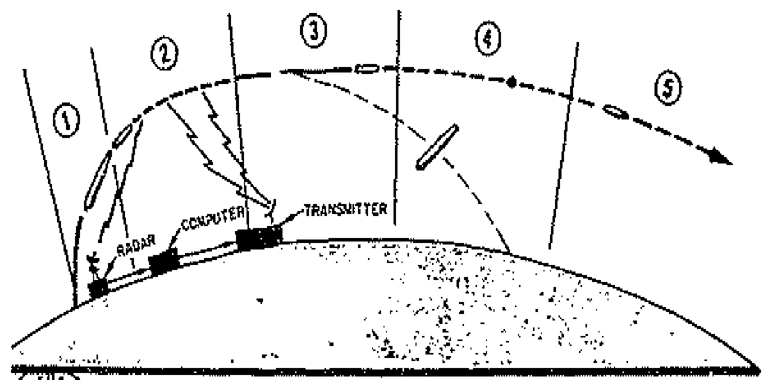
c. Telemetry ships are positioned as required by the specific mission of each flight. Figure I-3 shows a typical launch trajectory from Vandenberg Air Force Base, and Figure I-4 shows schematically a typical orbit. An additional objective of this program is the development of a controlled re-entry and recovery capability for the payload capsule (Figure I-5). An impact area has been established near the Hawaiian Islands, and a recovery

Flight History

DISCOVERER No.	AGENA No.	THOR No.	Flight Date	Remarks
0	1019	160	21 January	*AGENA destroyed by malfunction on pad. THOR refurbished for use on flight XI.*
I	1022	163	28 Feb 1959	*Attained orbit successfully. Telemetry received for 514 seconds after lift-off.*
II	1018	170	13 April	*Attained orbit successfully. Recovery capsule ejected on 17th orbit was not recovered. All objectives except recovery successfully achieved.*
III	1020	174	3 June	*Launch, ascent, separation, coast and orbital boost successful. Failed to achieve orbit because of low performance of satellite engine.*
IV	1023	179	25 June	*Same as DISCOVERER III.*
V	1029	192	13 August	*All objectives successfully achieved except capsule recovery after ejection on 17th orbit.*
VI	1028	200	19 August	*Same as DISCOVERER V.*
VII	1051	206	7 November	*Attained orbit successfully. Lack of 400-cycle power prevented stabilization on orbit and recovery.*
VIII	1050	212	20 November	*Attained orbit successfully. Malfunction prevented AGENA engine shutdown at desired orbital velocity. Recovery capsule ejected but not recovered.*
IX	1052	218	4 February	*THOR shut down prematurely. Umbilical cord mast did not retract. Quick disconnect failed, causing loss of helium pressure.*
X	1054	223	19 February	*THOR destroyed at T plus 56 sec. by Range Safety Officer.*
XI	1055	234	15 April	*Attained orbit successfully. Recovery capsule ejected on 17th orbit was not recovered. All objectives except recovery successfully achieved.*

Figure I - 2.

Powered Flight Trajectory



1. **First Stage Powered Flight**—2.5 minutes duration, 78 n.m. downrange, guided by programmed auto pilot.
2. **Coast Period**—2.4 minutes duration, to 350 n.m. downrange; guided and attitude controlled by inertial reference programmer, horizon scanner, gas reaction jets. Receives AGENA time to fire and velocity to be gained commands.
3. **Second Stage Powered Flight**—2 minutes duration, to 770 n.m. downrange. Guided and controlled by inertial reference programmer, horizon scanner, gas reaction jets (roll) gimballing engine, accelerometer.
4. **Vehicle Reorients to Nose Aft**—2 minutes duration, to 2,000 n.m. downrange. Guided and controlled by inertial reference programmer, horizon scanner and gas reaction jets.
5. **In-Orbit**—Guided and controlled (same as 4).

Figure I - 3.

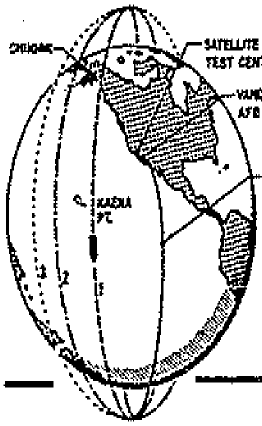


Figure I - 4.

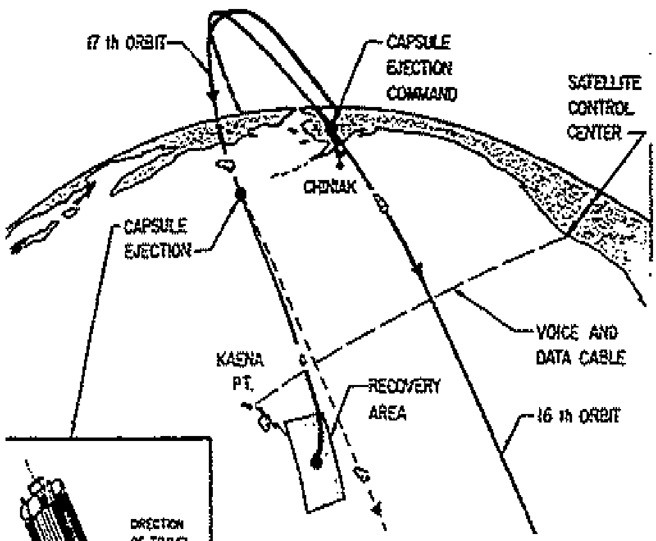
Orbital Trajectory

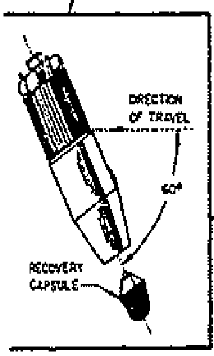
Schematic presentation of orbital trajectory following launch from Vandenberg Air Force Base. Functions performed by each station and a listing of equipment used by each station, are given in Figure I-1.

RECOVERY CAPABILITY

This objective was added to the program after the first launch achieved vehicle flight and orbit objectives successfully. It includes the orientation of the satellite vehicle to permit a recoverable capsule to be ejected from the nose section of the AGENA vehicle. Ejection is programmed to occur on command on the 17th orbit, for capsule impact within the predetermined recovery area south of Hawaii. Aircraft and surface vessels are deployed within the area as a recovery force.

Figure I - 5.





CAPSULE RECOVERY SEQUENCE

Capsule ejection command is sent to the satellite by the Chiniak, Alaska station on the 16th orbit. The vehicle reorients its position (see inset) to permit ejection to occur on a re-entry trajectory on the 17th orbit. The recovery capsule parachute is activated at about 50,000 feet, and the capsule beacon transmits a radio signal for tracking purposes. The recovery force is deployed in the recovery (impact) area.

S-E-C-R-E-T

10

	59											
	J	F	M	A	M	J	J	A	S	O	N	D
Launch Schedule (As of 8-1-1960)	1	1		1		2		2			2	
Vehicle Configurations	A											

	60											
	J	F	M	A	M	J	J	A	S	O	N	D
Launch Schedule (As of 8-1-1960)		2		1		1	2	2	2	2	2	1
Vehicle Configurations	A							B		C		

	61											
	J	F	M	A	M	J	J	A	S	O	N	D
Launch Schedule (As of 8-1-1960)	1	1	1	2	2	2	2					
Vehicle Configurations	C											

A. THOR—DM-18 / AGENA "A"

B. THOR—DM-21 MB-3 Block 1 / AGENA "B" XLR81-Ba-7

C. THOR—DM-21 MB-3 Block 2 / AGENA "B" XLR81-Ba-9

Figure I - 6.

S-E-C-R-E-T

force activated. Techniques have been developed for aerial recovery by C-119 aircraft and for sea recovery by Navy surface vessels. The recovery phase of the program has provided advances in re-entry vehicle technology. This information will be used in support of more advanced projects, including the return of a manned satellite from orbit.

2. Flight Test Vehicles

Versions of flight test vehicles.

The three versions of flight test vehicles used in the DISCOVERER Program are defined in the launch schedule shown in Figure I-6. Specifications for the two THOR configurations and three AGENA configurations used are given in Figure I-7. Drawings of the AGENA "A" and "B" configurations are shown in Figure I-8.

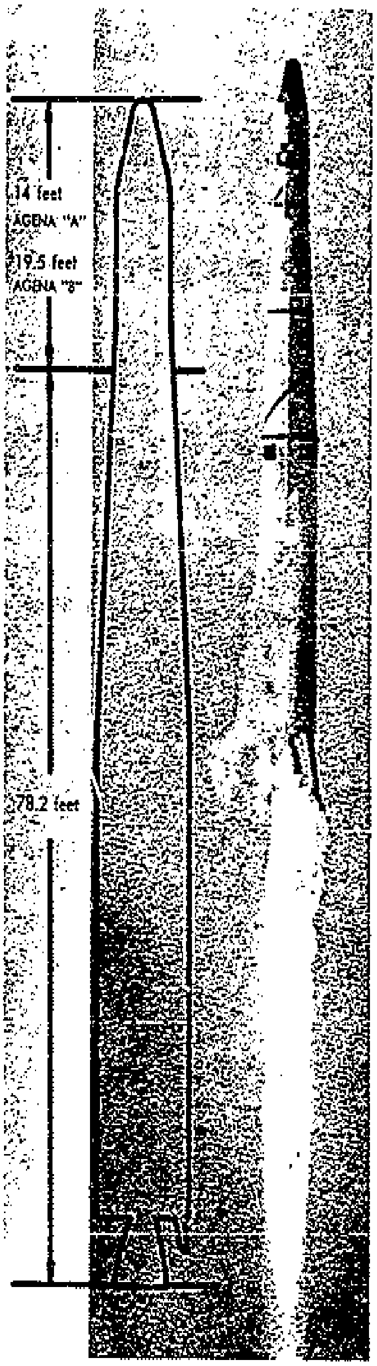
3. AGENA Vehicle Development

AGENA vehicle development.

a. The AGENA vehicle was originally designed by the Air Force as the basic satellite vehicle for Advanced Military Reconnaissance Satellite Systems Programs. Basic design was based on use of the ATLAS ICBM as the first stage. ATLAS trajectory characteristics and the stringent eccentricity requirements of the advanced programs led to the selection of a guidance system suited to achieving orbital injection in a horizontal attitude. As a result, an optical inertial system was developed for vehicle guidance and a gas jet system for orbital attitude control. An urgent need for attaining higher altitude orbits resulted in development of the AGENA "B" versions which included doubling the propellant capacity and addition of engine restart and extended burn capabilities. The YLR81-Ba-5 version of the LR81-Ba-5 engine, developed by Bell Aircraft for B-58 aircraft, is used on AGENA "A" vehicles.

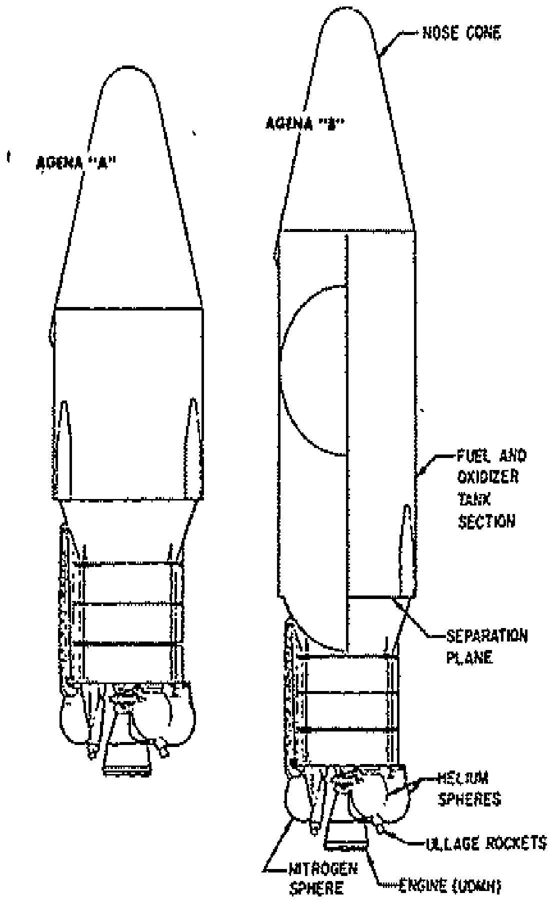
b. Early AGENA "B" vehicles will use a later version of this engine (YLR81-Ba-7), redesigned to use unsymmetrical dimethyl hydrazine fuel instead of JP-4. The majority of AGENA "B" vehicles will use the XLR81-Ba-9 engine, incorporating a nozzle expansion ratio of 45:1, and providing a further increase in performance capability.

c. An artist's concept of the DISCOVERER-AGENA satellite vehicle in orbit is shown in Figure I-9.



THOR BOOSTER	DM-18	DM-21
Weight—Dry	6,950	5,950
Fuel	33,750	33,750
Oxidizer (LOX)	68,300	68,300
GROSS WEIGHT (lbs.)	109,000	108,000
Engine	MB-3 Block 1	MB-3 Block 2
Thrust, lbs. (S.L.)	152,000	167,000
Spec. Imp., sec. (S.L.)	247.8	247.8
Burn Time, sec.	163	163

Figure I - 7



SECOND STAGE	AGENA "A"	AGENA "B"	
Weight—			
Inert	1,262	1,328	1,346
Payload equipment	497	887	915
Orbital	1,759	2,215	2,216
Impulse propellants	6,525	12,950	12,950
Other	378	511	511
TOTAL WEIGHT	8,662	15,676	15,722
Engine Model	YLR81-Ba-5	XLR81-Ba-7	XLR81-Ba-9
Thrust-lbs., vac.	15,600	15,600	16,000
Spec. Imp.-sec., vac.	277	277	290
Burn time-sec.	120	240	240

Figure I - 8.

Page 14 was exempted in its entirety.

E.O. 12065, Sec. 1-301 (c)(e)
Defense letter 10/15/79
NLE Date--10/29/79

Pages 13 through 26 were exempted in their entirety.

E.O. 12065, Sec. 1-301 (c)(E)
Defense letter 10/15/79
RLE Date 10/29/79

III. MIDAS PROJECT

(VERY EARLY WARNING SATELLITE)

A. Project Objective

1. General

a. Project Objective

MIDAS will provide early warning of ballistic missile attack.

The MIDAS project (Missile Defense Alarm System) is aimed toward establishing a series of satellites around the earth in polar orbits. These will carry payloads consisting of infrared detection scanners capable of detecting emanations from ballistic missiles being launched, as the missiles rise above the atmosphere.

2. Specific

Specific objectives.

a. To develop and demonstrate the equipment, techniques, and procedures for launching and placing into orbit the ATLAS-MIDAS combination vehicle.

b. To develop equipment for infrared data acquisition, transmission, and processing, and to demonstrate the capability of detecting and instantaneously reporting the launching of ICBM's and IRBM's through infrared scanning techniques with maximum use being made of the Ballistic Missile Early Warning System (BMEWS) equipment and techniques for data transmission.

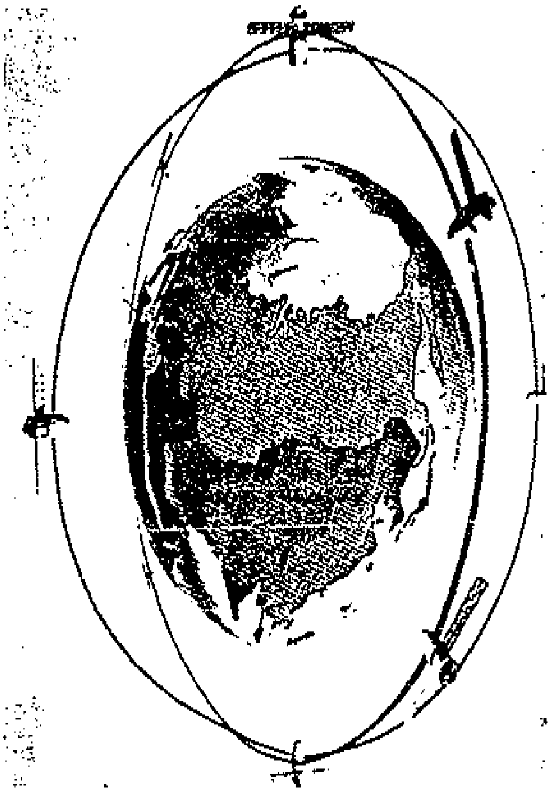
c. To develop solar auxiliary power arrays, and to demonstrate their capability.

d. To demonstrate the capability of the satellite engine to start, be stopped, and to restart.

e. To demonstrate the capability of adjusting and controlling the orbital period of the satellite vehicle.

f. To demonstrate MIDAS operational techniques and procedures for multi-satellite operation.

g. To demonstrate component reliability for a mean active orbital life of one year.



Proposed MIDAS system. Four satellites spaced equidistant in each of two orthogonal planes at 2000 n.m. altitude. Provides maximum coverage of USSR with minimum number of satellites.

Figure III - 1. Schematic of proposed MIDAS orbital system.

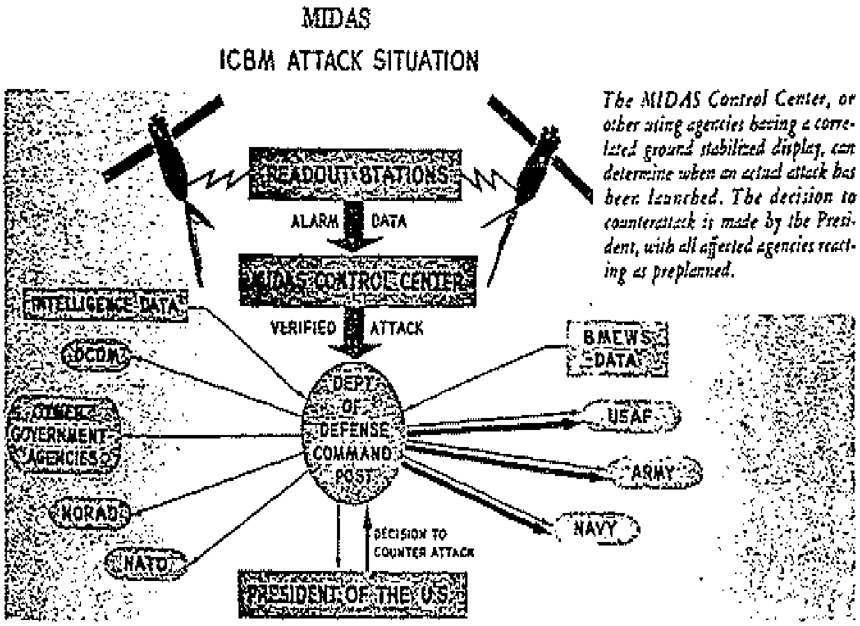


Figure III - 2. MIDAS data flow in an enemy ICBM attack situation.

B. Project Description

MIDAS provides infrared reconnaissance against enemy ICBM attack.

1. The MIDAS system is designed to provide continuous infrared reconnaissance of the Soviet Union and a satellite-borne ICBM attack alarm system for the United States. In the operational system, surveillance will be conducted by eight satellite vehicles in accurately positioned orbits. See Figure III-1.

How MIDAS operates.

2. The area under surveillance must be in line-of-sight view of the scanning satellite. Infrared radiation sensors capable of detecting the infrared energy emanating from the rocket plume would provide information on the number of missiles launched, the approximate launch location, and the approximate direction of flight of the missiles. The system will see only those sources of radiation which rise above the greater portion of the atmosphere. Each such sighting will be instantaneously communicated to at least one of three MIDAS readout stations strategically located in the United Kingdom, Greenland, and Alaska. These stations will be co-located with the Ballistic Missile Early Warning System (BMEWS) stations to the extent possible and will complement the BMEWS system. Data will be transmitted directly to the MIDAS Control Center where the information is processed, displayed and evaluated. See Figures III-2 and III-3. If an attack is determined to be under way, the intelligence is communicated to a central Department of Defense Command Post for relay to the President for decision to counter attack and then for relay to all national retaliatory, and defense agencies.

C. Progress Review - - March, April, May 1960

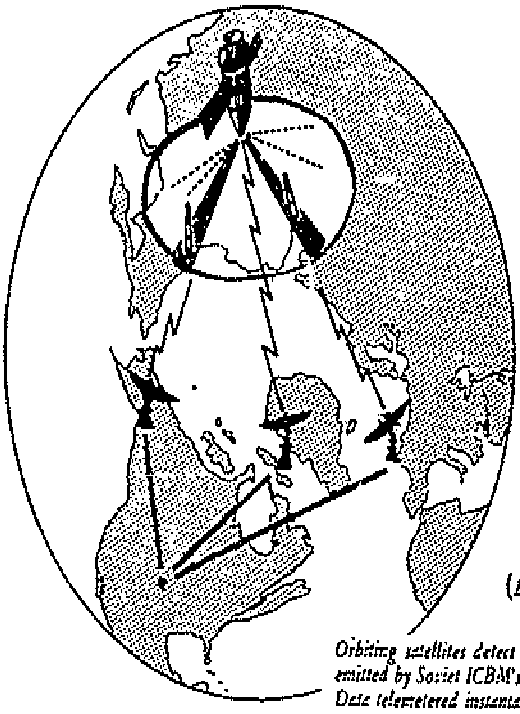
1. Flights

Second MIDAS flight test vehicle launched on 24 May.

a. The second MIDAS flight test vehicle was launched from the Atlantic Missile Range on 24 May. The countdown proceeded smoothly except for minor holds and liftoff was normal. Performance in regard to attainment of planned orbital parameters was outstanding. Acquisition was accomplished by every station.

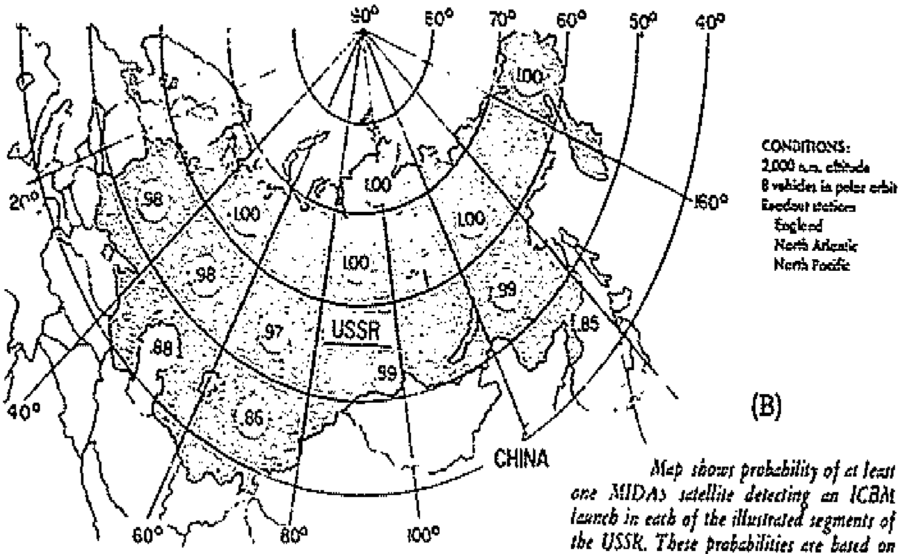
Programmed and actual flight parameters compared.

b. The high degree of success achieved in the launch phase is demonstrated by the comparison of programmed and actual ascent and orbital parameters given in Tables I and II.



(A)

Orbiting satellites detect infrared radiations emitted by Soviet ICBM's in powered flight. Data telemetered instantaneously to MIDAS Control Center via far north readout stations. Decoded data reveals approximately the number of missiles launched and launch location, direction of travel and burning characteristics.



(B)

Map shows probability of at least one MIDAS satellite detecting an ICBM launch in each of the illustrated segments of the USSR. These probabilities are based on geometric considerations.

Figure III - 3. (A) Illustration of MIDAS satellite's detection of infrared emissions and instantaneous reporting of data to MIDAS Control Center.
(B) Indication of probabilities of at least one MIDAS satellite detecting an ICBM launch over selected areas of the USSR.

Table I. Ascent Parameters

(Times shown are in seconds)

Parameters	Programmed	Actual
Booster Cutoff	148.8	146.8
Sustainer Cutoff	238.9	238.5
Vernier Cutoff	256.7	257.6
AGENA Ignition	551.6	551.2
AGENA Cutoff	661.1	660.0

Table II. Orbital Parameters

Parameters	Programmed	Actual
Apogee	262 N. Mi.	260 N. Mi.
Perigee	262 N. Mi.	254 N. Mi.
Period	94.1 Min.	94.44 Min.
Inclination Angle	32.64°	33.04°
Eccentricity	0.0003	0.0025
Injection Velocity	25,023 fps	25,052 fps
Satellite Life	40 Months	
Active (battery) life	28 days	

Thirty minutes of readout time recorded on first two passes.

c. Real time display at Vandenberg Air Force Base during the first pass indicated satisfactory operation of the Aerojet-General payload. A total of thirty minutes readout time was recorded during the first two passes. These data indicate a considerable amount of infrared background with "filter out". These data, unavailable until this flight, on the various levels of natural infrared radiation background will be most beneficial to later vehicles which must identify rocket exhaust temperatures. Payload data recordings have been received from subsequent vehicle passes, are being reduced, and will be analyzed.

Two additional MIDAS flights using THOR/AGENA vehicles obtained from the DISCOVERER Program.

d. Headquarters, Air Force, in March, authorized preliminary planning and design work in support of two additional MIDAS flights using THOR/AGENA vehicles obtained from the DISCOVERER Program. The polar orbiting payloads launched from Vandenberg Air Force Base would have a useful life of four days. Each pass (eight passes per day) would provide an average readout time of four minutes. These interim flights would provide basic payload data for evaluation and analysis.

Study made to extend MIDAS operational system to provide world-wide coverage.

e. An investigation is being made of the feasibility of extending MIDAS operational system capability to provide world-wide coverage. The study, scheduled for completion in June, will consider the number of additional satellites and ground stations required to support this program.

2. Component Development

a. Second Stage Vehicles

Full scale mock-up of solar auxiliary power array tested.

A full scale mock-up of the solar auxiliary power array was completed in March. Several functional tests of the mock-up have been performed successfully. Solar cell manufacture is in progress.

b. Infrared Scanner Units

Infrared scanner units for flights 3, 4, and 5 are being manufactured by Baird-Atomic, Inc.

Bearing problem with Baird-Atomic scanner causes schedule slippage.

(1) The binding of the turret bearing during March low temperature tests of the Baird-Atomic scanner indicated that a modification of the bearing was required. A new bearing has been installed and acceptance tests were resumed in May. Delivery of this unit to Lockheed Missiles and Space Division is expected to be delayed until mid-July.

Development of Baird-Atomic display consoles continues.

(2) The development of the two Baird-Atomic ground presentation consoles continues with delivery expected to be compatible with payload unit delivery.

Initial design continued of display consoles.

(3) Initial design of the advanced presentation unit for infrared payload ground display continued at General Electric. The first unit is scheduled for delivery in May 1961.

c. Communications and Control

Qualification tests of the 256-channel PAM multiplexer begin.

(1) Qualification testing of the engineering test model of the 256-channel (Model B) PAM multiplexer began in March. This unit will be used on the third MIDAS flight test. This multiplexer provides an increase in the amount of data transmitted and better quality then conventional telemetry commutation systems.

Procurement authorized for a third Programmable Integrated Control Equipment (PICE) unit.

(2) Procurement has been authorized for a third Programmable Integrated Control Equipment (PICE) unit for installation in December as part of the interim MIDAS equipment of the New Boston, New Hampshire tracking station. This unit will be identical to the units at the Satellite Test Center (STC) and Vandenberg Air Force Base except for a smaller memory unit and fewer access registers. Commands from the STC to the satellite, orbital predictions and other data are transmitted through the STC PICE to the tracking station PICE for distribution in the station or transmission to the satellite. Tracking, payload data and other data are returned through PICE to the STC for computation, display, or storage.

3. Facilities

a. Vandenberg Air Force Base

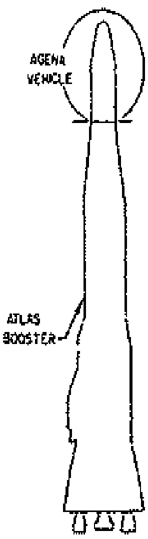
Vandenberg data acquisition and processing building ready.

Construction of the data acquisition and processing building was essentially complete in May and ready for installation of technical equipment. A redesign of this building to accommodate a revised computer configuration was initiated in May. Construction has started and will be completed in July.

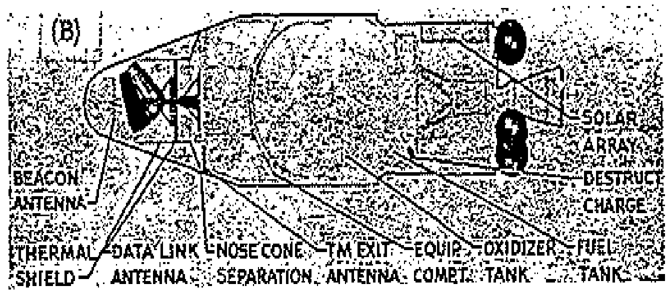
b. North Pacific Station

Construction resumed at Alaska stations.

Construction of the technical facilities at Donnelly Flats, Alaska, and the support facilities at Fort Greely, Alaska, were resumed on 1 April. Facilities are scheduled for completion on an incremental basis from July through October.



(A)

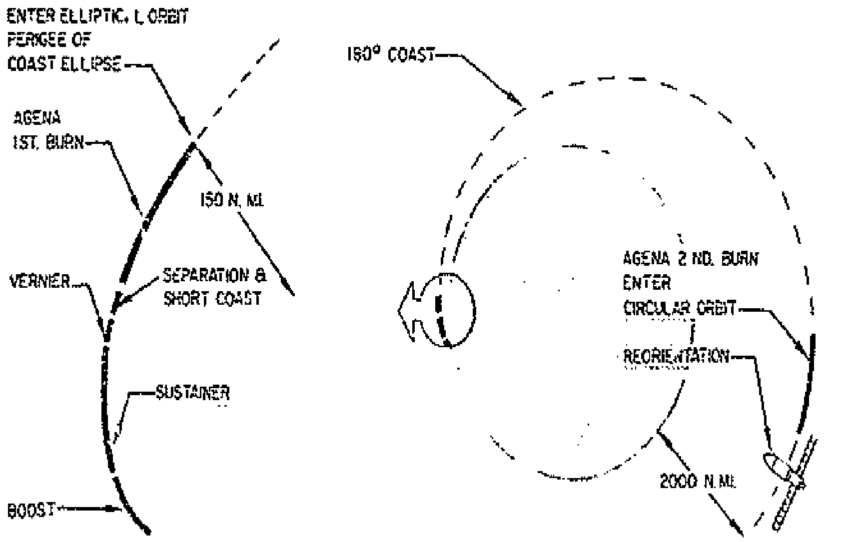


NOTE: AGENA "A" configuration except for solar paddles (AGENA "B" only).

BOOSTER—ATLAS ICBM	
Weight—Wet	15,100
Fuel, RP-1	74,900
Oxidizer (LOX)	172,300
GROSS WEIGHT (lbs.)	262,300
Engine—MA-2	
Thrust (lbs. vac.) Boost	356,000
Sustainer	82,100
Spec. Imp. (sec. vac.) Boost	286
Sustainer	310

SECOND STAGE	AGENA "A"	AGENA "B"
Weight—		
Inert	1,534	1,763
Payload equipment	3,245	1,641
Orbital	4,780	3,404
Impulse Propellants	6,423	12,950
Fuel (UDMH)		
Oxidizer (IRFNA)		
Other	606	758
GROSS WEIGHT (lbs.)	11,809	17,112
Engine	YLR81-Ba-5	XLR81-Ba-9
Thrust, lbs. (vac.)	15,600	16,000
Spec. Imp., sec. (vac.)	277	290
Burn Time, sec.	120	240
Restart Provisions	No	Yes

Figure III - 4. The MIDAS Launching Vehicle configuration:
(A) Line drawing of the ATLAS - AGENA combination vehicle.
(B) The AGENA second - stage vehicle.



Launch-to-orbit trajectory for flights 3 and subsequent. Optimum ATLAS boost, guided by radio-inertial system. AGENA ascent (coast, burn, coast, second burn) provides attitude reference. Also governs velocity magnitude and direction by inertial guidance system monitored by horizon scanner. Orbital attitude maintained by reaction wheel and gas jets.

Figure III - 5. The planned MIDAS launch - to - orbit trajectory.

c. North Atlantic Station

Site surveys continue.

Surveys are being continued to find a suitable site for this station.

d. East Atlantic Station

Negotiations initiated in April to permit use of RAF Station Kirkbride.

Negotiations were initiated in April to permit use of the Royal Air Force Base at Kirkbride for this station. Facilities and land to be retained by USAF will be identified and submitted to Headquarters USAF for subsequent negotiations with the British Government by 15 June. Criteria package for this station will be completed for transmittal to the British Minister of Public Works in October.

D. Project History and Management

History and management.

The MIDAS Program was included in Weapon System 117L when WS 117L was transferred to the Advanced Research Projects Agency early in 1959. ARPA subsequently separated WS 117L into the DISCOVERER, SAMOS and MIDAS Programs, with the MIDAS objectives based on an infrared reconnaissance system. The MIDAS (Missile Defense Alarm System) Program was directed by ARPA Order No. 38, dated 5 November 1958 until transferred to the Air Force on 17 November 1959. An ARDC development plan for a ten flight R&D program has been approved. This R&D program will make possible the achievement of a reliable operational system by 1963.

Ten flight R&D program approved.

E. Project Features

1. Launching Vehicle

The launching vehicle is ATLAS-AGENA combination.

The MIDAS infrared reconnaissance payload is engineered to use a standard launch vehicle configuration. This consists of a "D" Series ATLAS missile as the first stage and the AGENA vehicle, powered by a Bell Aircraft rocket engine as the second, orbiting stage. See Figure III-4. The first two of the ten R&D flights used the AGENA "A" vehicle which was programmed to place the payload in a circular 261 nautical mile orbit. Subsequent flights will utilize the ATLAS/AGENA "B" configuration which will be programmed to place the payload in a circular 2,000 nautical mile polar orbit. See Figure III-5.

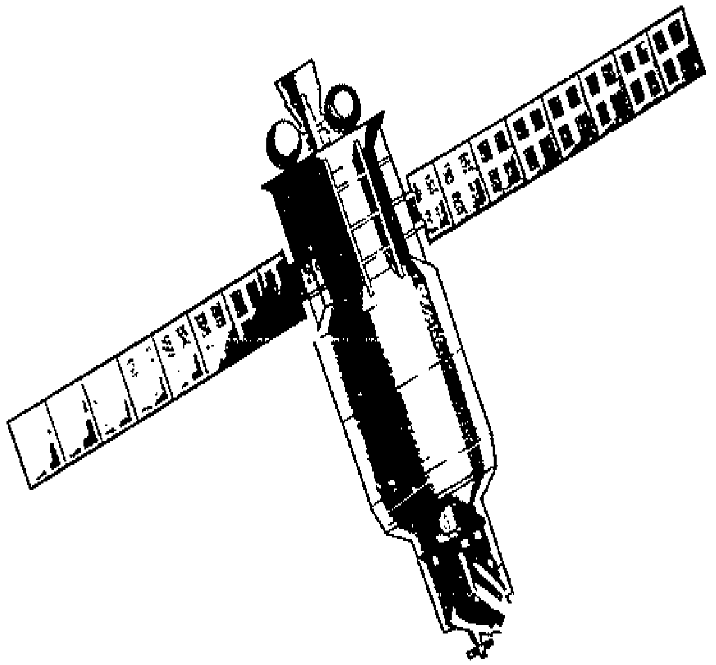


Figure III - 6. Artist's concept of MIDAS satellite.

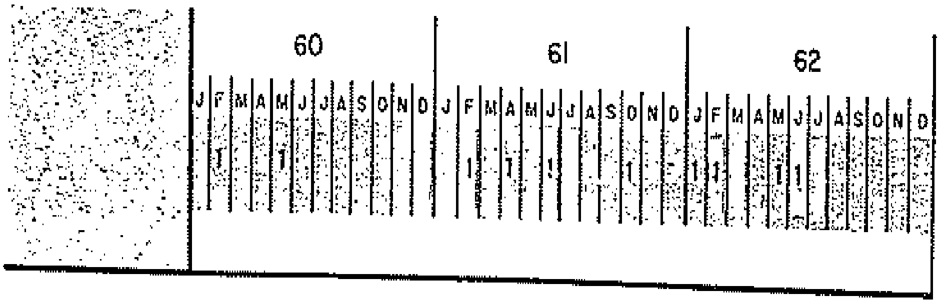


Figure III - 7. MIDAS Launch Schedule.
(As of 1 August 1960)

2. The MIDAS Satellite

MIDAS satellite.

An artist's concept of the MIDAS satellite is shown in Figure III-6.

3. The MIDAS Launch Schedule

Launch schedule.

The MIDAS launch schedule is shown in Figure III-7.

4. Operational Planning

System operational in 1963.

The MIDAS system should become operational in 1963.

IV. TRANSIT PROJECT

(NAVIGATION SATELLITES)

A. Project Objective

1. General

Objectives -- General

The objective of the TRANSIT Project is to provide an accurate and reliable means of fixing precisely the position of military surface craft, submarines, and possibly aircraft on an all-weather, global basis, and of civil vehicles with somewhat reduced accuracy.

2. Specific

Objectives -- Specific

a. Demonstrate ability to navigate by means of the Doppler TRANSIT system.

b. Demonstrate ability to correct for refraction effect of ionosphere by a two-frequency method.

c. Improve understanding of the effects of ionospheric refraction of radio waves.

d. Increase accuracy in geodetic measurements, including the attainment of a better knowledge of the earth's shape and of the distances between land masses.

e. Acquire a better knowledge of the gravitational field of the earth so that precise orbits can be determined.

f. Improve orbital tracking techniques.

g. Provide an accurate time standard for precise navigational purposes.

h. Develop personnel proficiency in the program.

i. Develop computing and analysis techniques for the data handling process required in the operational system.

j. Verify design of satellite and operation of subsystems, including telemetry, power supply, transmitting systems, command system, and de-spin.

k. Develop ground station tracking and command equipment.

l. Demonstrate an auxiliary payload/TRANSIT satellite separation technique.

B. Project Description

General

TRANSIT Project developing a reliable, accurate system of navigation.

a. The TRANSIT Project consists of the design, development, and test of a system of navigation conceived by the Applied Physics Laboratory, The Johns Hopkins University, and based on the Doppler shift observed in radio signals from artificial earth satellites. The TRANSIT Project will provide a reliable means of fixing the position for surface craft, submarines, and aircraft anywhere in the world more precisely than has heretofore been possible, and will provide under any weather conditions more accurate means of maritime and aerial navigation than is now available.

System to be operational in 1962.

b. The system will be operational in 1962. It will consist of (1) several satellites in orbit about the earth at altitudes optimum for accurate tracking, (2) a network of tracking stations supplying tracking data to a computing complex to maintain an accurate ephemeris of each satellite, (3) a means of supplying to each navigation station the ephemerides of the satellites as well as reference time standard signals, and (4) navigating equipment designed to receive the Doppler data from the satellite and to determine efficiently a navigational fix from these data. See Figure IV-1, schematic system operation.

C. Progress Review -- March, April, May 1960

1. Satellites

TRANSIT 1B was successfully launched April 13, 1960

a. TRANSIT 1B was launched into orbit around the earth April 13, 1960, by a THOR-ABLE STAR vehicle, from Cape Canaveral, Florida. (TRANSIT 1B was the backup vehicle to TRANSIT 1A which did not achieve orbit.) See Figures IV-2 and IV-3. TRANSIT tracking operations and analysis of telemetered data indicate that the operation of all equipment was normal. See Figure IV-4. The separation technique intended for use in subsequent pick-a-back launchings was successful, and de-spin of the satellite from its initially rapid

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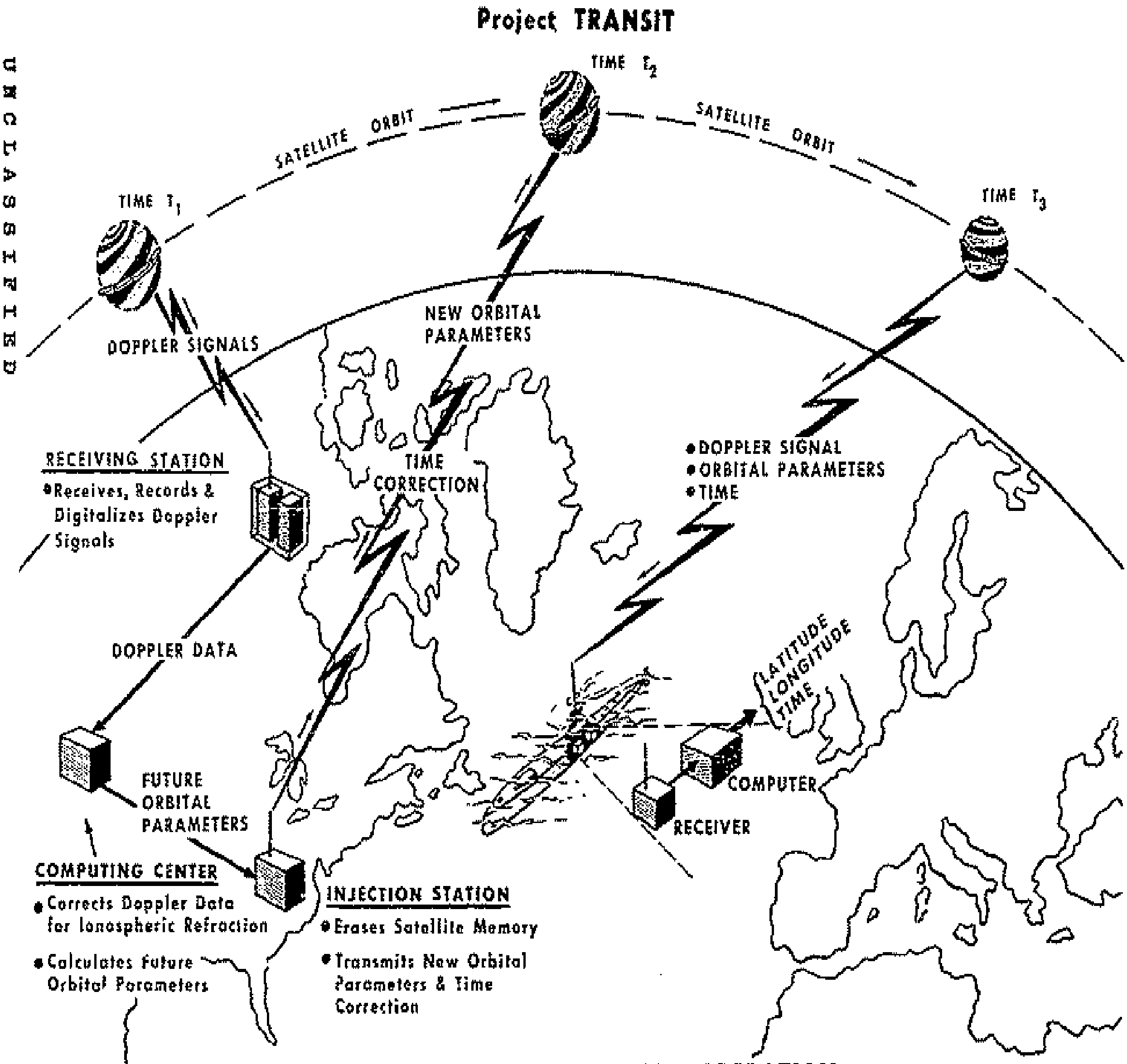

Figure IV - 1. SCHEMATIC SYSTEM OPERATION

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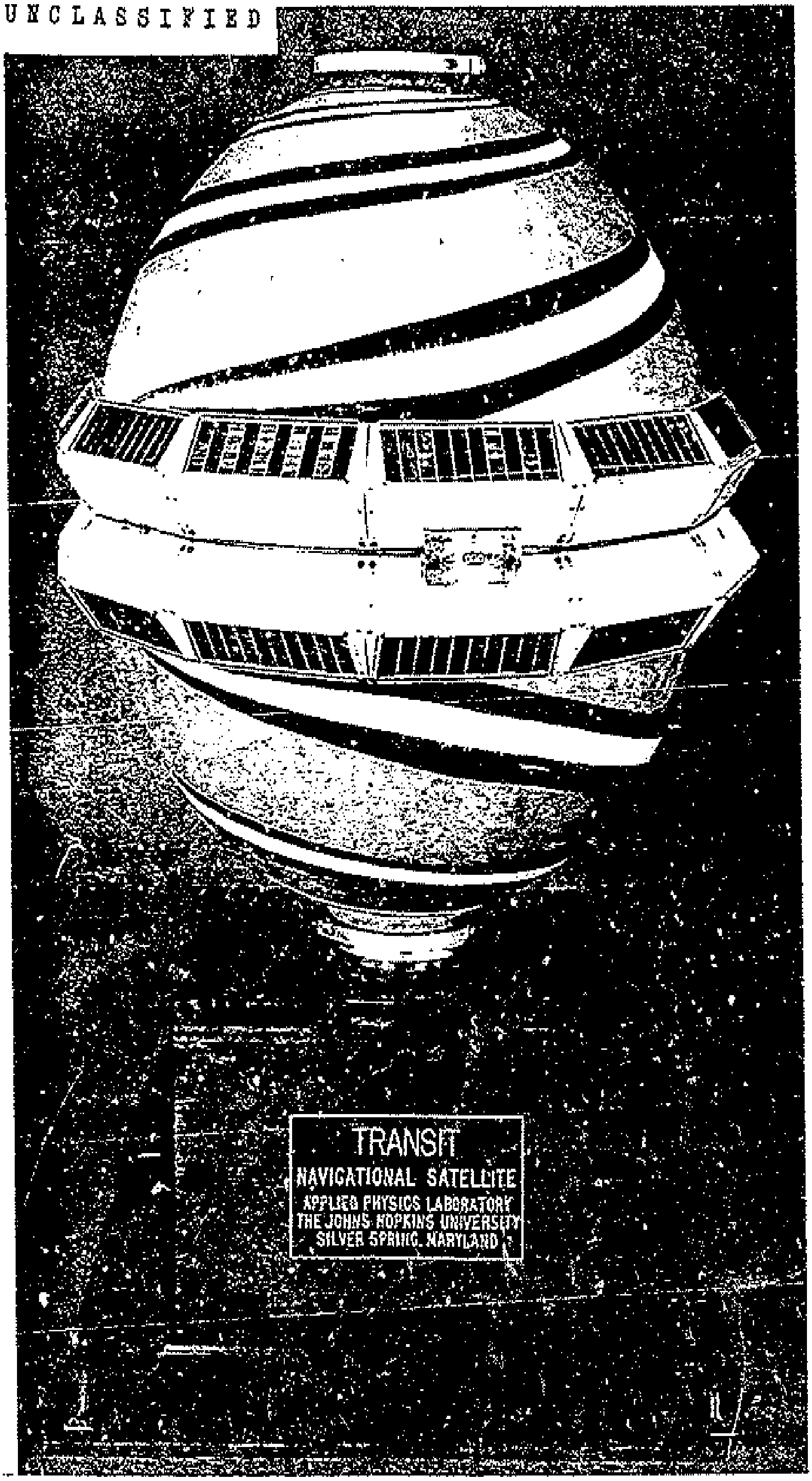
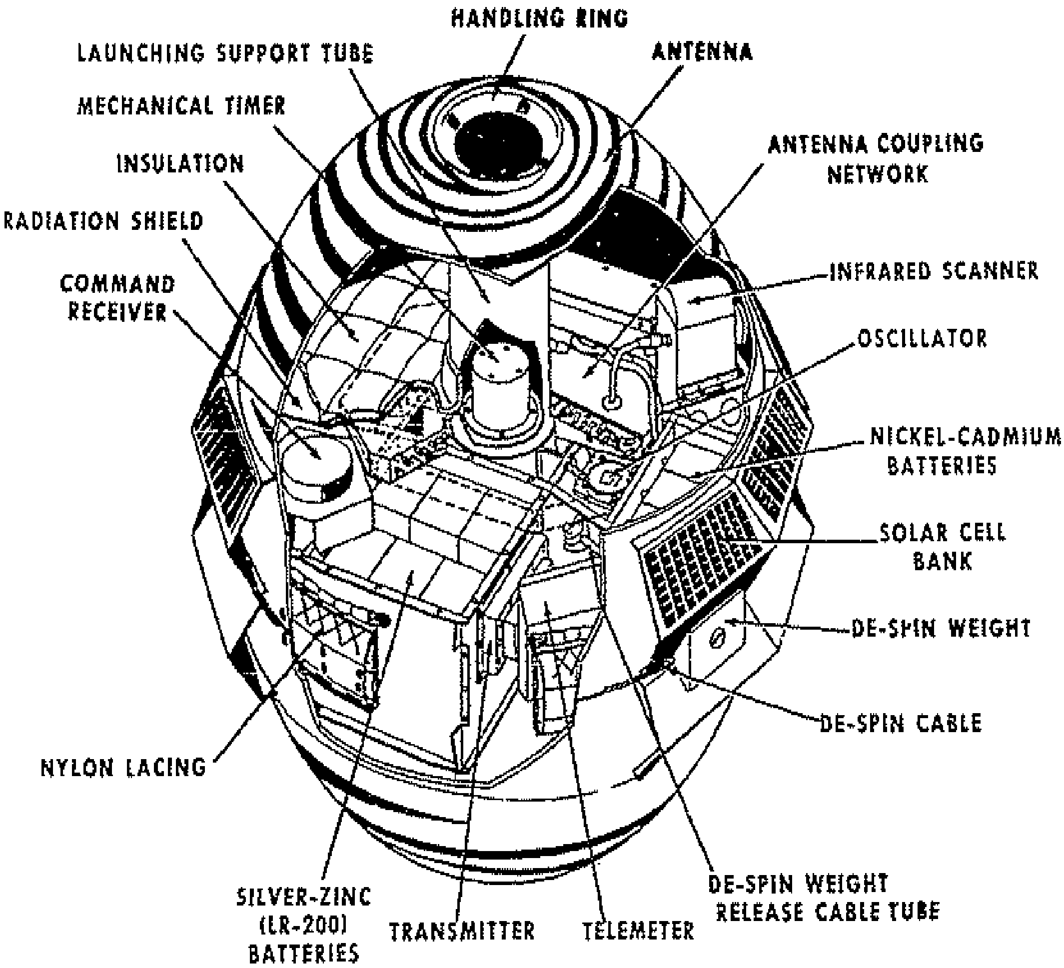


Figure IV - 2. TRANSIT navigational satellite on stand.

Project TRANSIT



TRANSIT IB
SATELLITE CUTAWAY VIEW

Rev APR 1960

Figure IV - 3.

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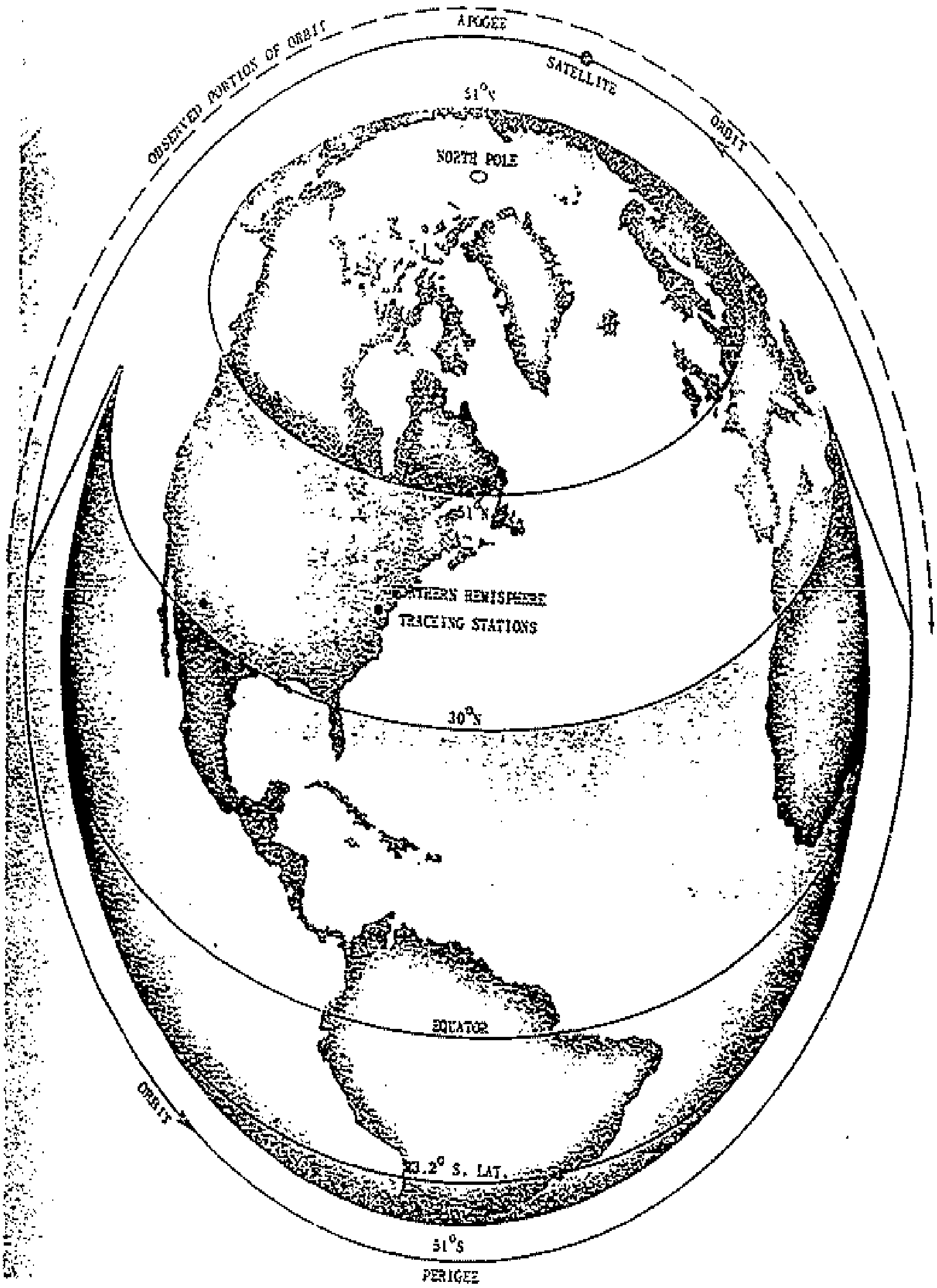

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Figure IV - 4. The observed portion of the orbit of TRANSIT 1B from northern hemisphere tracking stations.

spin rate occurred. The TRANSIT Doppler technique for orbit determinations has been yielding successive ephemerides having reasonable internal consistency. On May 18, the orbit had a perigee of 227.7 statute miles and an apogee of 467.2 statute miles. Although the satellite was not injected into the desired orbit, the perigee being considerably below the required value, several test objectives have been met and notable progress has been made on others. Predicted design temperatures have been verified. Results of using the two-frequency method in correction for refraction effects and results of initial position-determination experiments have been most favorable. Active investigation of the gravitational field of the earth and of the geoid has begun.

TRANSIT 2A, structurally and functionally similar to the 1B, includes an improved telemetering system, more solar panels, and an electronic clock

b. The 2A satellite was fabricated and completely tested. The 2A will differ from the 1B in orbital inclination and will be powered entirely by solar energy. It will contain a clock permitting precise worldwide time correlation. It will also carry a Canadian receiver to measure galactic noise and as another secondary experiment, 2A will carry the GREB satellite in a pick-a-back fashion. (TRANSIT 2A was successfully launched into orbit 22 June 1960 and is operating satisfactorily.)

TRANSIT 3A will be similar to the 2A. It will incorporate a data storage system.

c. Package layout of the 3A (formerly 2B) satellite has been made, and the electronic subsystems are in breadboard stage. The 3A will be able to store approximately 300 bits of digital information and to read out about 100 bits per second.

TRANSIT-type oscillators were installed in DISCOVERER XI, launched April 15, 1960.

d. The third attempt to perform a TRANSIT-on-DISCOVERER experiment was successful in the launching of DISCOVERER XI satellite into orbit April 15, 1960. The TRANSIT equipment, transmitting on 162 and 216 mc, performed well and the tracking stations reported good signal reception. However, because the launching occurred only two days after the TRANSIT 1B launching, some passes of DISCOVERER were forfeited and others were incomplete as the computer time and analysis that could be given this experiment were limited. In addition, the drag force acting on DISCOVERER was large and variable. Therefore, the orbit determinations performed are probably accurate only to a few miles.

TRANSIT FLIGHT HISTORY

TRANSIT No.	Launching Vehicle	Launch Date	Remarks
1A	Thor-Able	17 Sept.1959	The vehicle third-stage engine did not ignite at the end of the coast period. This resulted in satellite plus third stage assembly re-entering the atmosphere and being destroyed over the North Atlantic Ocean at approximately the nominal impact point for the second stage. However, valuable data concerning operation of satellite and ground station equipment were obtained.
1B	Thor-Able Star	13 April 1960	Attained orbit about the earth. Short-term objectives achieved. Notable progress is being made on long-term objectives. Satellite subsystems and ground stations operating satisfactorily.
TRANSIT-on-DISCOVERER	DISCOVERER XI	15 April 1960	Attained orbit successfully. TRANSIT equipment performed well. Its signals first verified DISCOVERER was in orbit.

Figure IV - 5. Flight History of TRANSIT.

TRANSIT LAUNCH SCHEDULE
(As of 12 July 1960)

Satellite Configuration	Calendar Years 1959	1960	1961	1962
1A	17 Sept.			
1B		13 April		
TRANSIT-on-DISCOVERER XI		15 April		
2A		22 June		
3A		Nov.		
3B		Dec.*		
4A			May	
4B			July	
5A				Jan.
5B				March
Operational Satellites				July - Aug.

*Transit 3B will be launched only if 3A launching fails.

Figure IV - 6. TRANSIT Launch Schedule.

e. Additional TRANSIT-on-DISCOVERER tests are planned.

2. Receiving Stations

TRANSIT receiving stations have been successfully tracking TRANSIT 1B satellite.

All seven TRANSIT receiving stations began tracking TRANSIT 1B satellite from time of launch April 13, 1960, as scheduled. The stations also tracked TRANSIT-on-DISCOVERER when DISCOVERER XI was launched April 15, 1960. One station is equipped to track the TRANSIT 1B satellite on its four frequencies, 216, 162, 54, and 324 mc, and the others on only two of the coherent frequencies. One of the oscillators in TRANSIT 1B is so much better than expected that, in order to capitalize on its excellent performance, an improved frequency reference that also serves as a time standard is being employed by the receiving stations. Although the operation of all the stations has been good, minor improvements in equipment and experience gained in the tracking operations are providing increasingly better tracking data.

C. Project History and Management

Establishment of project and responsibilities.

TRANSIT Project was established early in 1958 under the direction of the Advanced Research Projects Agency (ARPA). On 9 May 1960, project responsibility was transferred from ARPA to the Department of the Navy by the Secretary of Defense. Prime contractor for the program is the Applied Physics Laboratory. TRANSIT satellites are launched from Atlantic Missile Range, Cape Canaveral, Florida, with over-all launching responsibility assigned to Ballistic Missile Division, U. S. Air Force.

D. Project Features

1. Flight History

Flight History.

A history of TRANSIT and TRANSIT-on-DISCOVERER launchings is shown in Figure IV-5.

2. Launch Schedule

Launch Schedule.

The launch schedule of TRANSIT satellites is shown in Figure IV-6.

3. Ground Support Facilities

Ground Support Facilities.

Tracking and command functions are performed by the ground support facilities listed in Figure IV-7.

TRANSIT GROUND SUPPORT FACILITIES

Facility	Equipment	Flight Function
Control Center APL	C	Over-all control. Issues acquisition data to tracking stations for subsequent passes. Receives tracking data from stations.
Station 01 APL/JHU	AB	Orbital tracking and telemetry data reception. Initiates command signals for switching satellite mode of operation.
Station 02 Univ. of Texas Austin, Texas	A	Orbital tracking.
Station 03 N.M. State Univ. Las Cruces, N. M.	A	Orbital tracking. Received last signal heard before DISCOVERER XI went off the air.
Station 04 Mobile Van at Univ. of Washington, Seattle, Washington	A	Orbital tracking. Observed the first pass of TRANSIT 1B.
Station 05 Mobile Van at Naval Air Station, Argentia, Newfoundland	A	Orbital tracking.
Station 06 Lasham, England	A	Orbital tracking.
Station 07 Tuslog Detachment 28 Karamusel, Turkey	A	Orbital tracking. First station to observe despin of TRANSIT 1B. Received first signals after injection of DISCOVERER into orbit proving it was in orbit.
Station 25 USS OBSERVATION ISLAND Port Canaveral, Florida	A	Orbital tracking.
APL Computing Center Howard County, Md.	D	Orbital computation, station alerts, navigating computation, basic scientific analysis.
Naval Weapons Laboratory Dahlgren, Virginia	E	Backup to the 1103A computer for orbital computation and station alerts

Equipment

A. Timing equipment, Doppler receiving and recording equipment, Satellite Doppler data processing and transmitting equipment.
B. Telemetry receiving and recording equipment.
C. Communication equipment.
D. 1103A computer.
E. NORC computer.

Figure IV - 7. TRANSIT Ground Support Facilities.

V. NOTUS PROJECT

(COMMUNICATIONS SATELLITES)

A. Project Objective

1. General

NOTUS objective is to establish a global military communications system.

a. The objective of the NOTUS Project is to obtain at the earliest practicable date a family of satellite-borne communications repeaters, which will provide a global military communications system. This system will be capable of meeting military requirements for long range radio communication links of high reliability, security, and large capacity under conditions of natural or man-made interference.

The NOTUS Project consists of two parts -- COURIER and ADVENT.

b. The NOTUS Project is a dual research and development program aimed at demonstrating the feasibility of placing communications satellites into useful orbits and being able to communicate between distant points on the earth's surface by means of satellite repeaters for extended periods of time both on a delayed time and a real-time basis. These two parts of the NOTUS Project are known as (1) COURIER, a delayed repeater satellite project and (2) ADVENT, a real-time repeater satellite project.

2. Delayed Repeater Communications Satellite - COURIER

Initial phase of NOTUS is the delayed repeater satellite, COURIER.

The initial phase of the NOTUS Project is the development of an orbiting delayed repeater communications satellite (COURIER) that will receive and store messages from one ground station and transmit and deliver the messages to another ground station at a later time and place in its orbit.

3. Instantaneous Repeater Communications Satellite - ADVENT

Second phase of NOTUS is the instantaneous repeater satellite, ADVENT.

The second phase of the NOTUS Project is the development of a real-time repeater communications satellite, ADVENT, located in a 24-hour synchronous (hovering) equatorial orbit, that will provide instantaneous point-to-point communications between

any number of transmitting and receiving stations within the line-of-sight beam from the satellite. Three such satellites equally spaced about the equator would provide instantaneous communications service between any number of surface stations wherever located on earth except for the polar regions.

B. <u>COURIER Project</u>

1. <u>Project Objectives</u>

Objective is to develop a delayed repeater satellite communications system.

The basic obje 'ive of the COURIER Project is to determine the feasibility of developing a delayed repeater communications system based upon an orbiting satellite. See Figure V-1.

2. <u>Project Description</u>

COURIER Project comprises two launchings

The COURIER delayed repeater communications satellite project comprises two launchings into circular orbits of 650 nautical miles altitude and inclined 28.3 degrees to the equator. These two launchings and resultant tests are the first phase of the NOTUS Project to demonstrate the feasibility of active communications satellites to play an effective role as part of a world-wide military communications network.

3. <u>Progress Review -- March, April, May 1960</u>

a. <u>General</u>

COURIER launchings were originally scheduled for 19 July and 1 Sept. 1960

As of 31 May 1960, COURIER 1A is scheduled to be launched on 19 July 1960 and COURIER 1B on 1 September 1960. (As of 27 July 1960, these launchings were tentatively rescheduled for 16 August and 4 October, respectively).

b. <u>Satellites</u>

COURIER 1A being system tested.

(1) COURIER 1A satellite, developed by Philco Western Development Laboratories, is undergoing system tests. The satellite will be airlifted to the Atlantic Missile Range in late June for its final pre-launch tests.

Military Uses of Space: 1946-1991

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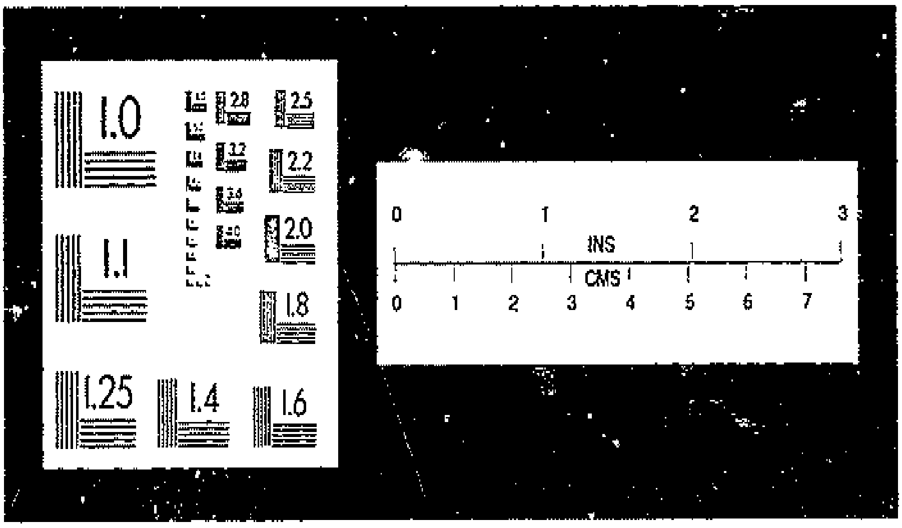

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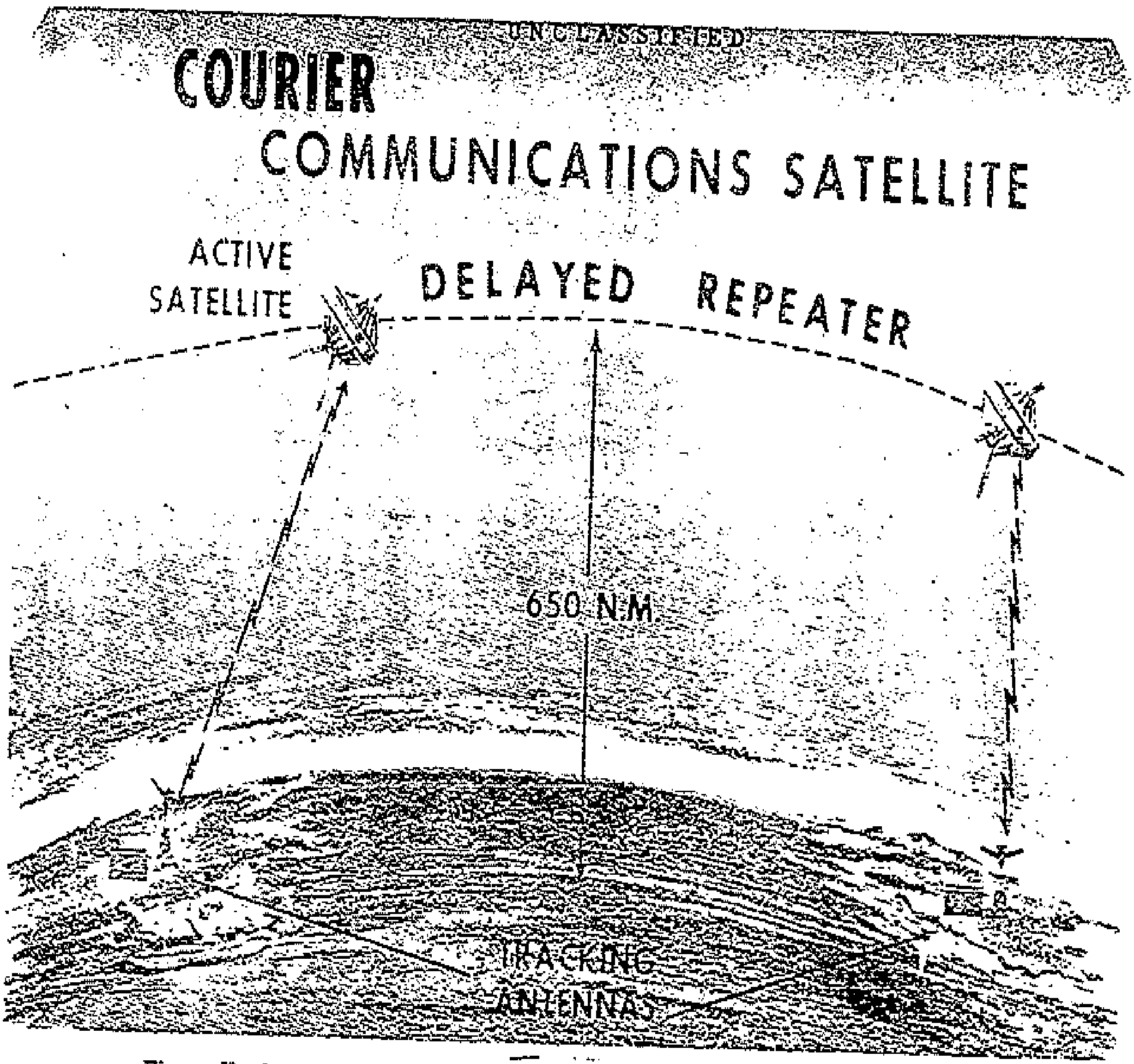

Figure V - 1. The concept of the COURIER delayed repeater communications satellite which accepts and stores messages from one COURIER ground station and delivers them to another COURIER ground station at a later time in its orbit.

COURIER 1B on schedule.

(2) The development of the COURIER 1B satellite is on schedule.

c. Checkout Van

Checkout van due at AMR by June 15.

International Telephone and Telegraph Laboratories shipped the checkout van to Philco on May 13 for a final system checkout with flyable satellite components. This van will be shipped to the Atlantic Missile Range by June 15.

d. Ground Stations

Ground stations work on schedule.

(1) No problems are anticipated in meeting the work schedules for the two ground stations -- (a) at Camp Salinas, Puerto Rico, and (b) at Fort Monmouth, New Jersey. The two stations will have identical tracking, telemetry, command, and communications data transmission and reception facilities for the COURIER in-orbit experiments.

Ground antenna equipment installed.

(2) All ground antenna equipment, fabricated by Radiation, Inc., has been completed and installed at both ground station sites. Acceptance tests of the antenna equipment will be completed by June 15.

Arrangements made for tracking and administrative communications net.

(3) Commercial power is now available. Arrangements have been started for a COURIER tracking and administrative communications net between Fort Monmouth, Camp Salinas, the Pentagon, NASA Space Communications Center and the U. S. Army Signal Research and Development Laboratory. The scheduled completion date is June 15. The Army System Communications Division will arrange for the necessary facilities, which will be operated by the U. S. Army Communications Agency.

Stations operational during June

(4) Upon the arrival of the operations vans from International Telephone and Telegraph Laboratories during June, the ground stations will become operational. Testing for the final phase will then be started and will continue until the August 16 launch date for COURIER 1A.

4. Project History

a. General

COURIER Project is follow-on of the SCORE Project.

(1) The President's 1958 Christmas message delivered to the world by the SCORE satellite demonstrated the feasibility of world-wide communications by means of an earth satellite repeater.

(2) The COURIER communications satellite, a delayed repeater, is a follow-on satellite stemming from the SCORE Project and is the forerunner of a series of communications satellites.

b. Establishment and Management

COURIER Project was established by ARPA.

COURIER Project as a task of NOTUS Project was established on 27 July 1959 by the Advanced Research Projects Agency. Technical responsibility for developing the COURIER satellites and the two ground stations to be used during the research and development test and evaluation phase is assigned to the Army Signal Corps. Air Force Ballistic Missile Division's THOR-ABLE STAR boost vehicle will place the payload into orbit, and Space Technology Laboratories is responsible for systems engineering and technical direction of the boost vehicle, including automatic guidance for the ABLE STAR stage.

5. Project Features

a. General

Completion in Dec. 1960.

The COURIER Project will be completed by December 1960.

b. Launchings

Two launchings of COURIER.

Two launchings of COURIER satellites from the Atlantic Missile Range are scheduled, one in August and one in October 1960.

c. Launching Vehicle

Booster is the THOR-ABLE STAR.

The two-stage THOR-ABLE STAR booster combination will be used. See Figure V-2.

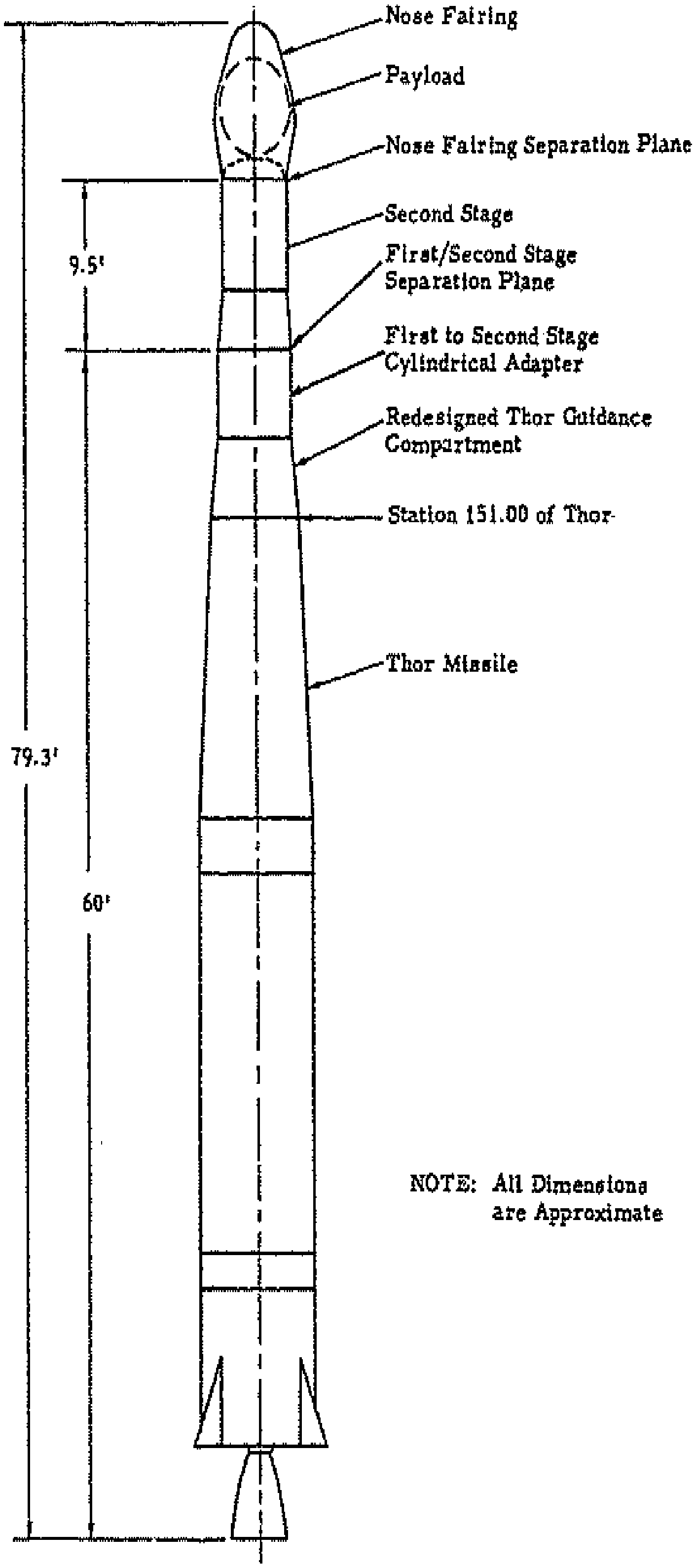

Figure V - 2. The outboard profile of the THOR-ABLE STAR booster combination which will be used to place the COURIER communications satellite into orbit.

d. Powered Flight Trajectory

Powered Flight trajectory outline.

The flight vehicle will be launched eastward from Cape Canaveral, Florida. The satellite payload will be separated from the second-stage vehicle approximately over southeastern Africa. See Figure V-3. At this time it will be placed in its planned circular orbit at an altitude of 650 nautical miles and inclined at 28.3 degrees to the equator.

e. Satellite

COURIER satellite design mock-up.

The satellite payload is a 51-inch sphere weighing about 500 pounds. The transistors, batteries, tubes and other parts are housed in 33 "black boxes" arranged on three shelves as shown in the design mock-up in Figure V-4. Communications messages are sent and received by two flush, omni-directional microwave antennas while telemetry and tracking signals are received by four VHF whip omni-directional antennas. A pattern of solar cells virtually covers the entire sphere and, by the effect of the sun's radiation, maintain a charge in the nickel-cadmium batteries. COURIER uses microwave frequencies for communications purposes. It has 4 receivers and 4 transmitters for communications data. There are two receivers for ground station command signals, two transmitters for telemetry and two beacon signal transmitters. Duplication of major components provides redundancy and greater reliability. There are 5 magnetic tape recorders, each with a capacity of storing 15,000,000 bits of teletype traffic (about 300,000 words). This capacity is reached in five minutes. There is also provision for storing five minutes of voice traffic on one of the five recorders. The satellite will have a spin imported to it for equalization of temperature from the sun's radiation.

f. Ground Stations

Two ground stations used by COURIER in R&D phase.

Two ground stations at Fort Monmouth, New Jersey, and Camp Salinas, Puerto Rico, will operate during the initial research and development test and evaluation phase of COURIER. Each station has a 28-foot parabolic antenna with a dual feed system which accommodates all signals -- beacon, command, telemetry, and communications -- in the VHF and microwave bands used by the satellite. The ground stations also automatically track the satellite.

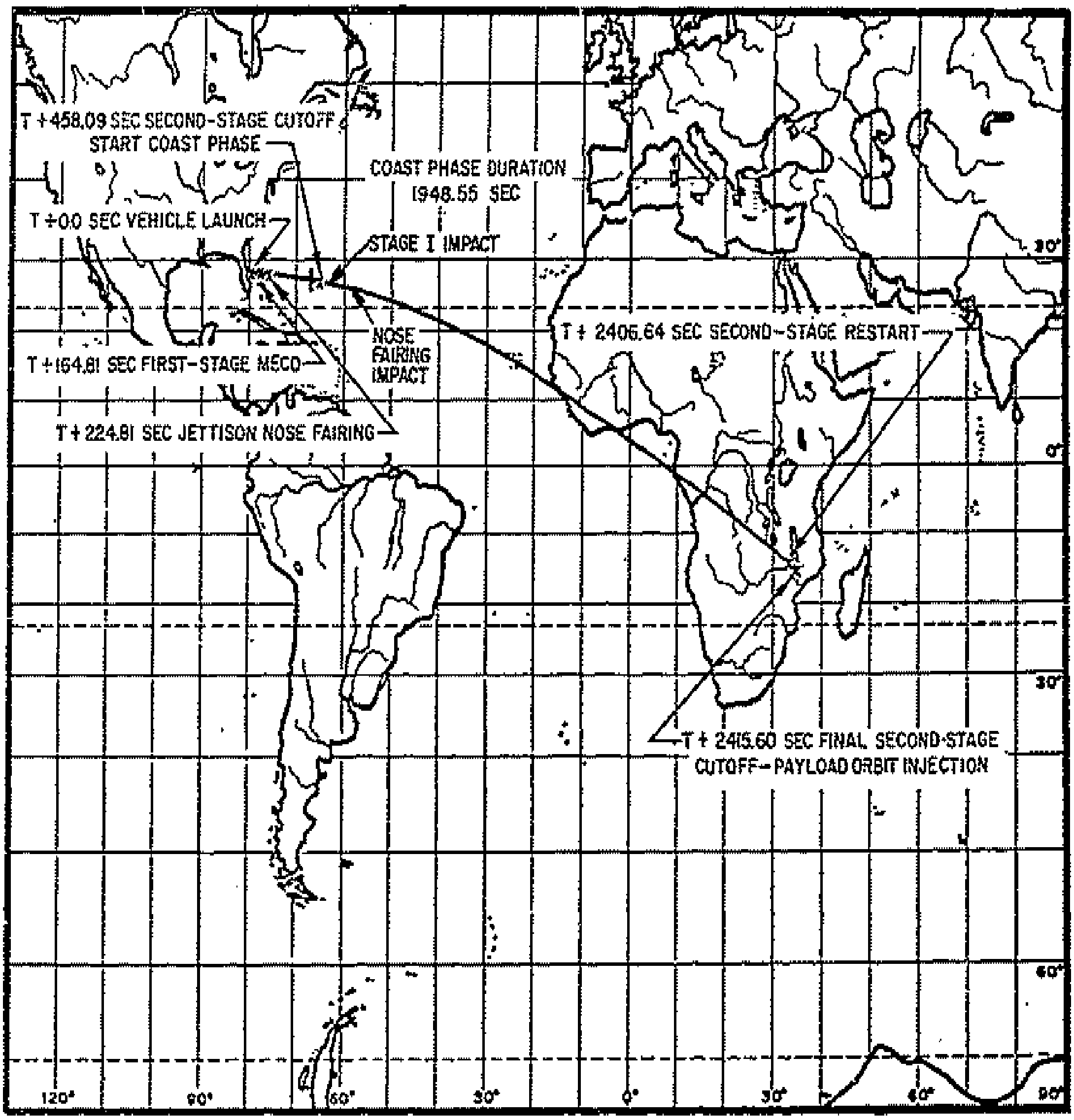

Figure V - 3. The planned powered flight trajectory for placing the COURIER communications satellite into orbit.

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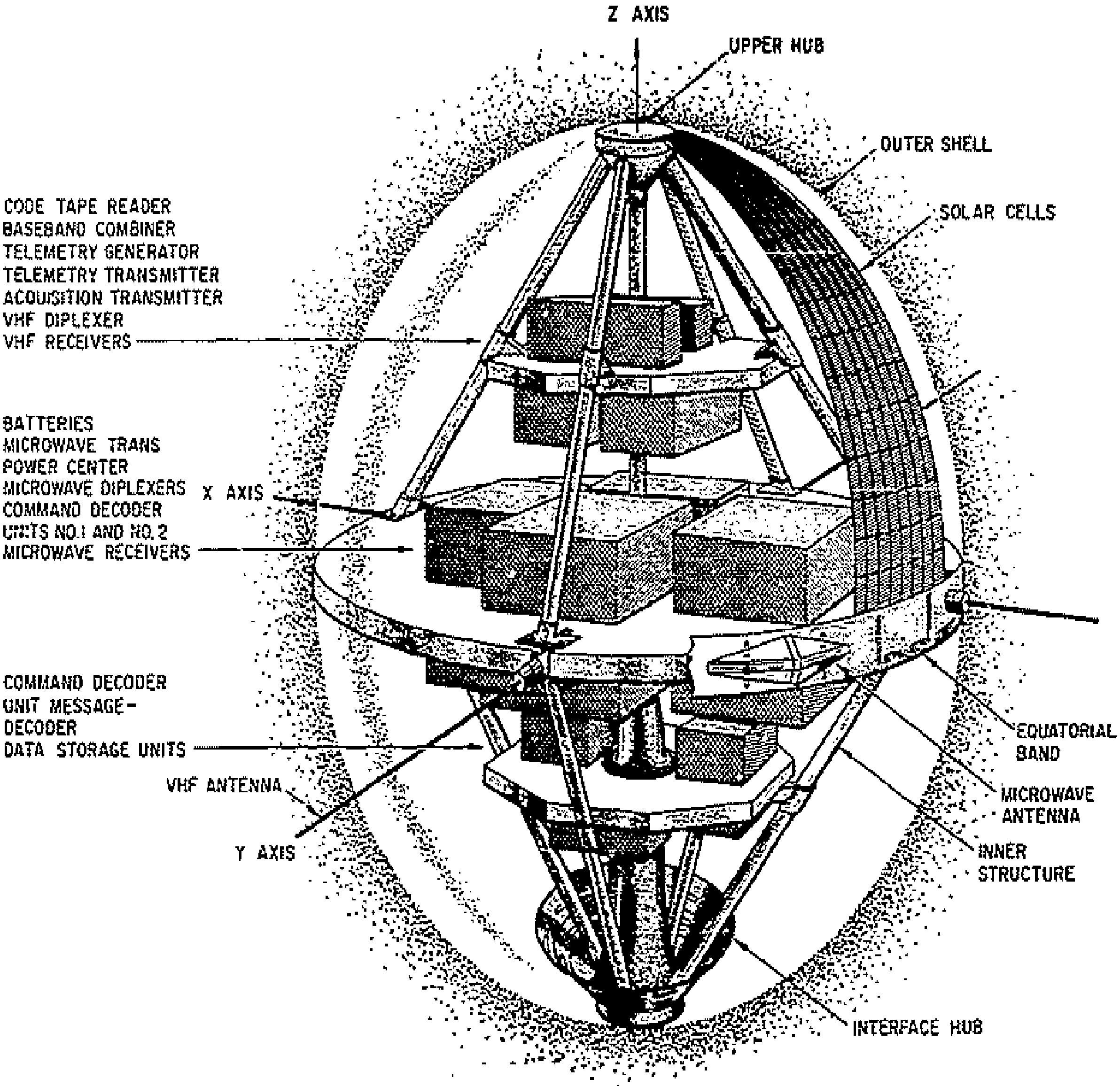

Figure V - 4. The design mock-up of the COURIER communications satellite payload.

C. ADVENT Project

1. Project Objective

General

Objective is to develop an instantaneous repeater satellite communications system.

The basic objective of the ADVENT Project is to demonstrate the feasibility of developing a real-time high channel capacity global (excluding the polar regions) surface-to-surface communications capability by means of a satellite repeater. In operational configuration, three such satellites equally spaced about the equator would be instantaneously available for communications between any number of surface stations wherever located on the earth, except for the polar regions above and below 80 degrees North and South latitudes.

2. Project Description

General

ADVENT to be developed in two phases.

(1) The ADVENT Project is particularly oriented toward meeting the generalized requirements of the three military services to augment their present long haul point-to-point high precedence traffic networks. Because of its complexity, the rigid tolerances that its several subsystems must meet, the extreme altitude of its orbit and the current non-availability of a reliable ATLAS-CENTAUR booster required to place its approximately 1200-pound payload into the 24-hour orbit, ADVENT will be undertaken in two phases.

Phase I comprises three ATLAS-AGENA "B" firings into low altitude orbits.

(2) Phase I of ADVENT will involve three ATLAS-AGENA "B" firings from the Atlantic Missile Range into orbits of relatively low altitude - 5000 nautical miles - inclined 34.2 degrees to the equator. These firings are scheduled for December 1961, March 1962, and June 1962. The purpose of these launchings will be to test the soundness of the satellite design configuration and the ability of the satellite subsystems to stabilize the satellite in attitude and to control the orientation of the solar cells. Pending the availability of satellite and ground station communications subsystems, these launchings will also be devoted to testing power storage devices and preliminary microwave communications system designs or major components thereof in actual space environment.

Phase II comprises seven ATLAS-CENTAUR firings into high altitude orbits.

(3) Phase II of ADVENT will be devoted to completing the development of a real-time microwave communications satellite repeater and placing it into a 24-hour synchronous (hovering) equatorial orbit of of 19,300 nautical miles altitude. See Figures V-5 and V-6. Seven ATLAS-CENTAUR launchings from the Atlantic Missile Range will be used for this purpose. The system should be capable of providing point-to-point communications in full duplex operation with long-life, reliable components, anti-jamming protection, and some adaptation of crypto security techniques. It is the purpose of Phase II to provide a basic technology for future systems and to provide logical development steps towards larger payload systems for future military requirements.

3. Progress Review - March, April, May 1960

a. General

ADVENT requirements established from former STEER, TACKLE, and DECREE projects.

During the reporting period, the previous three phases of program accomplishment (STEER, TACKLE, and DECREE) were modified into a single R&D, 24-hour synchronous equatorial orbit program (ADVENT). Studies and investigations previously directed toward the three-phase accomplishment of program objectives were continued where possible or redirected in compliance with ADVENT requirements. The R&D effort for a ground-to-satellite-to-aircraft UHF communications requirement was cancelled. A single R&D program was directed toward attaining a 24-hour global satellite microwave communications system (surface-to-surface).

b. Final-Stage Vehicle

Efforts directed toward single configuration final-stage vehicle.

(1) The first half of the reporting period was devoted to preliminary efforts related to providing an interchangeable UHF or microwave equipment installation for a single configuration final-stage vehicle compatible with either AGENA or CENTAUR vehicles.

Design transition to microwave mission initiated.

(2) During the latter part of April, primary efforts were directed toward feasibility studies and testing programs. An orderly transition of final-stage vehicle design from the UHF mission to the microwave mission was initiated.

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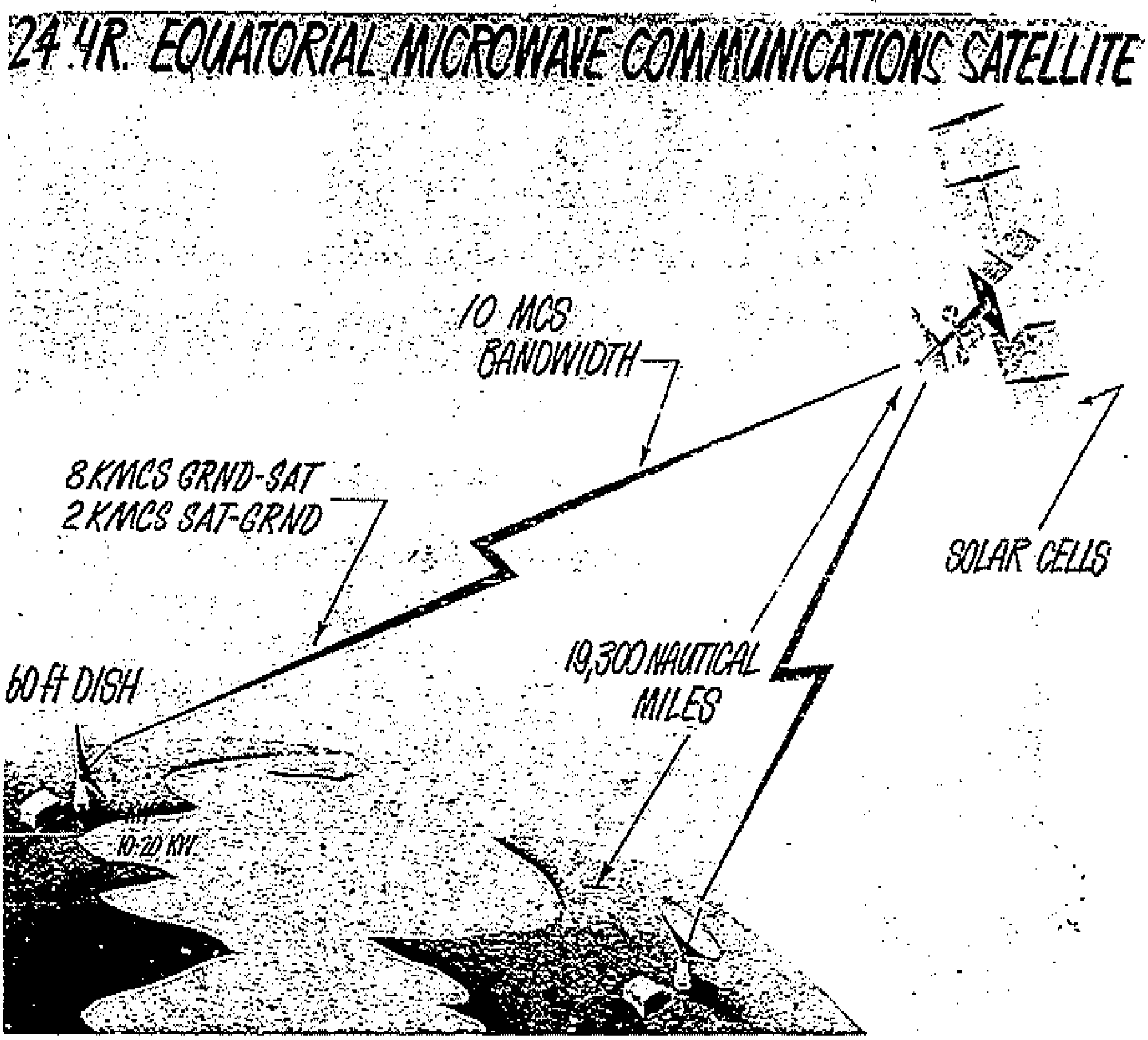

Figure V - 5. Schematic of ADVENT instantaneous repeater satellite communications system.

Figure V-5

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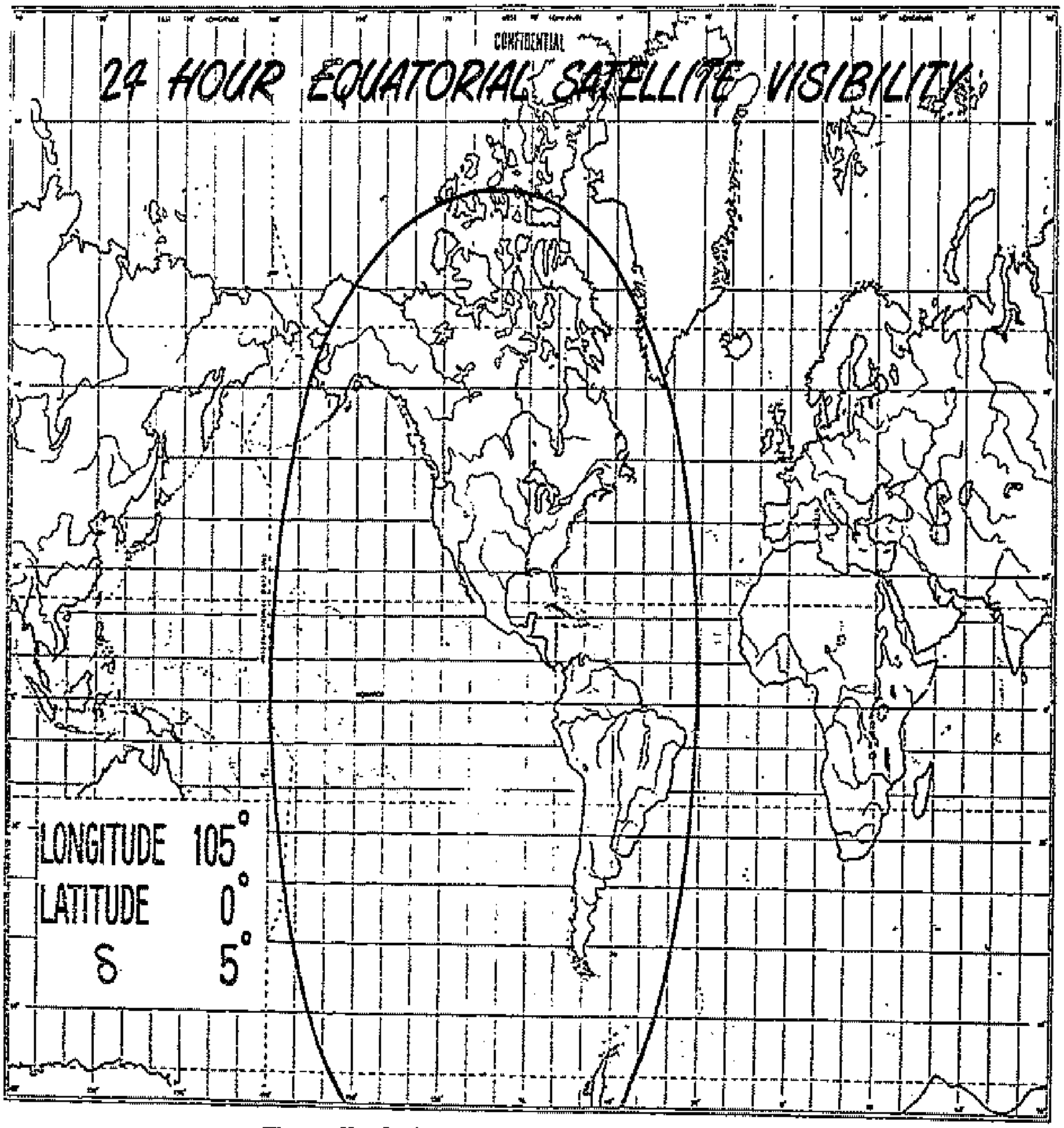

Figure V - 6. Map of ADVENT satellite on-station visibility.

Figure V-6

c. Microwave Communications

Coordination meeting held on May 10-12.

(1) Representatives of the U. S. Army Signal Research and Development Laboratory/Air Force Ballistic Missiles Division/Space Technology Laboratories attended a coordination meeting on May 10-12. Drafts of work statements were reviewed, satellite interface areas involving the communications equipment were discussed and consideration was given to contractor relationships.

Subsystem integration meeting held on May 25.

(2) A microwave communication subsystem integration meeting was held on May 25 at the U.S. Army Signal Research and Development Laboratory. Present scheduling concepts were discussed for compatibility with the program. Critical interface relationships requiring immediate resolution were defined.

d. Launching Vehicle

ARPA requests ATLAS/CENTAUR capability study.

At the request of the Advanced Research Projects Agency, a summary was prepared on the ATLAS/ CENTAUR capability for placing a final stage vehicle into a 24-hour circular equatorial orbit. The ATLAS/ CENTAUR combination can place into orbit a payload of either 818 pounds or 1,170 pounds with a 3-sigma certainty of success. The factors affecting payload weight are the CENTAUR burn period with relation to crossing of the equator, and velocity deficiency at separation.

e. Ground Stations

Ground stations site surveys initiated.

Site surveys have been initiated on the East and West Coasts of the United States to determine suitable locations for ADVENT ground stations. Topographical studies of the middle Atlantic area are being made by air to insure meeting the line of sights requirement.

4. Project History

a. General

ADVENT Project is reorientation of STEER, TACKLE and DECREE

(1) ADVENT stems from what formerly was a three avenue approach (STEER, TACKLE and DECREE) to meet the Services' needs for global, high channel capacity, real time, urgent command and control traffic for surface

to mobile air, fixed surface to mobile surface and fixed surface to fixed surface communications by means of a satellite repeater.

(2) The ADVENT communications satellite, a 24-hour real-time repeater, is a Department of Defense supported research and development program directed toward proving the feasibility of communicating at microwave frequencies between surface elements both fixed and mobile on a global basis except for the polar regions.

b. Establishment and Management

ADVENT Project was established by ARPA.

(1) The real-time satellite repeater effort was initiated by the Advanced Research Projects Agency (ARPA) on 5 November 1958 by Memorandum to the Air Force (ARDC) and Army (OCSIGO) asking for a jointly prepared Development Plan for a 24-hour Communications Satellite to meet these requirements:

(a) Broadcast type communications to ground and mobile (airborne and waterborne) units.

(b) Ground-to-air and ship-to-shore two-way communications through a satellite repeater, and

(c) Intercontinental point-to-point communications through satellite repeater.

These programs subsequently became known as STEER (6-hour SAC Polar Communications Satellite), TACKLE (6-hour Advanced Polar Communications Satellite) and DECREE (24-hour Global Communications Satellite). STEER, TACKLE and DECREE were cancelled as independent projects on 29 February 1960 and were integrated into the single ADVENT Project. ADVENT was reoriented to its present concept on 11 July 1960 by the elimination of the surface to mobile air polar capability.

System and Subsystem Responsibilities Assigned.

(2) The Air Force (ARDC) under ARPA's policy and technical guidance was given the over-all systems integration responsibility for carrying out these separate efforts with the Army Signal Corps being responsible for developing the microwave communications equipment for TACKLE and DECREE, and the Navy for the

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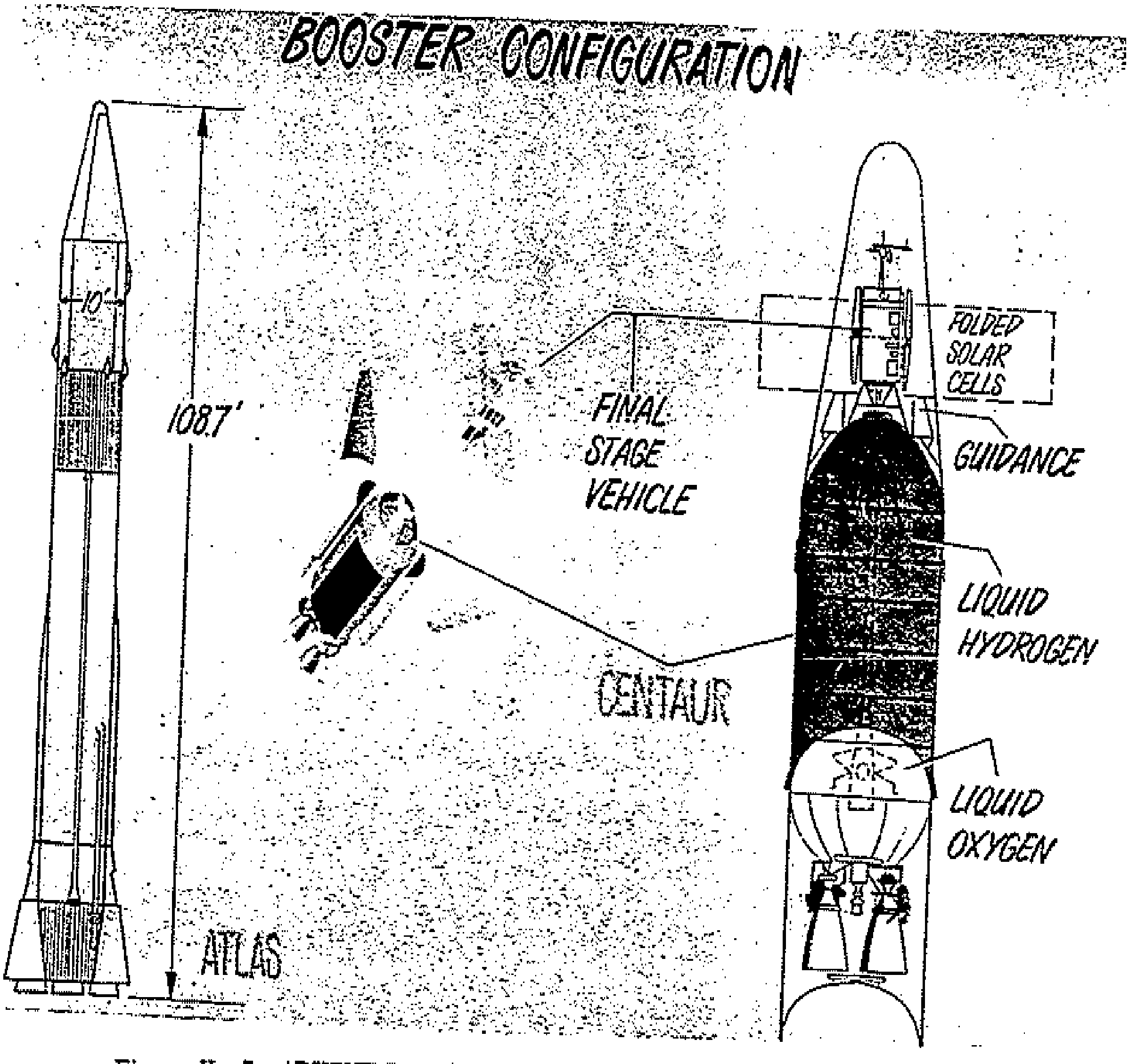

Figure V - 7. ADVENT Launching Vehicle Configuration - - ATLAS - CENTAUR.

Figure V-7

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instrumentation of a surface vessel to participate in these programs. This management structure remains essentially unchanged under ADVENT.

5. Project Features

a. General

Completion in December 1963.

The ADVENT Project is scheduled for completion in December 1963.

b. Launchings

Ten ADVENT launchings using ATLAS-AGENA "B" and ATLAS CENTAUR boosters.

Three ATLAS-AGENA "B" launchings are currently scheduled for December 1961, March 1962 and June 1962 from the Atlantic Missile Range into a nominal 5600 nautical mile altitude orbit inclined to the equator to test the functioning and reliability of the final stage vehicle (satellite) subsystems. Seven ATLAS CENTAUR launchings (See Figure V-7) are currently scheduled for December 1962, February 1963, March 1963, May 1963, July 1963, September 1963 and November 1963 from the Atlantic Missile Range into the 24-hour synchronous 19,300 nautical mile circular equatorial orbit. The first two of these will be on NASA launches 9 and 10 of their ten-vehicle research and development program for the CENTAUR. The purpose of these seven launches is to prove the feasibility of the ADVENT concept to provide a militarily useful surface-to-surface communications capability on a global scale.

c. Powered Flight Trajectories

Three powered flight trajectories.

ADVENT will use three separate powered flight trajectories. One for the ATLAS-AGENA "B" and two for the ATLAS CENTAUR. The ATLAS-AGENA "B's" will be launched eastward from the Atlantic Missile Range into inclined circular 6-hour 5,600 nautical mile altitude orbits. This will result in four separate and distinct earth tracks which are repeated every 24 hours. See Figure V-8. The ATLAS-CENTAUR's will be launched eastwardly from the Atlantic Missile Range. The first of the two trajectories to be used will be by direct injection into the 24-hour circular synchronous orbit (19,300 nautical miles altitude) at 105 degrees West longitude from a 100 nautical mile parking orbit on the second equatorial (northerly) crossing of the equator. See Figure V-9. The second trajectory to be used will be by injection into a walking orbit at 85°

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Figure V-8

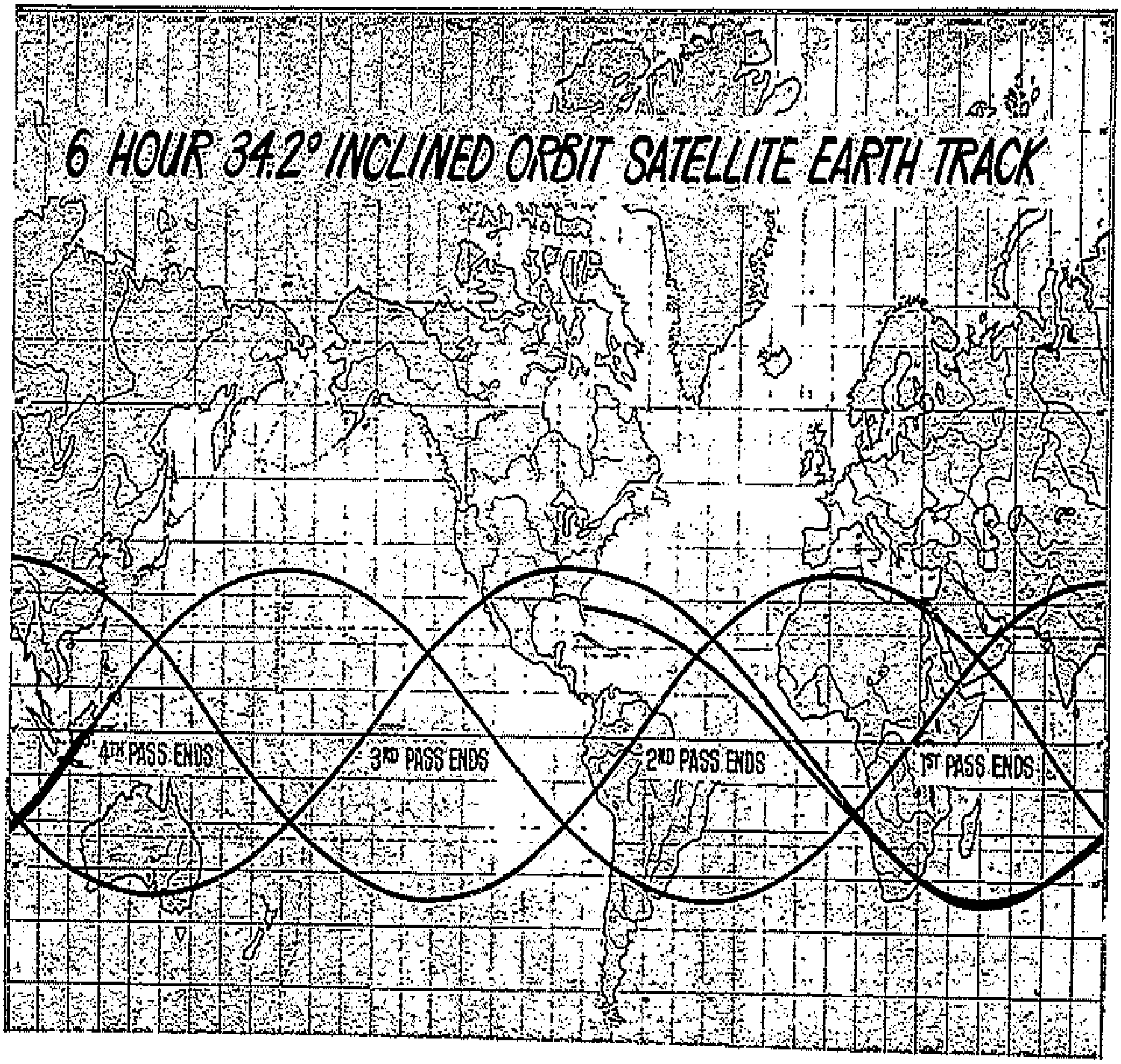

Figure V - 8. Earth Track of ADVENT satellite in 6-hour orbit.

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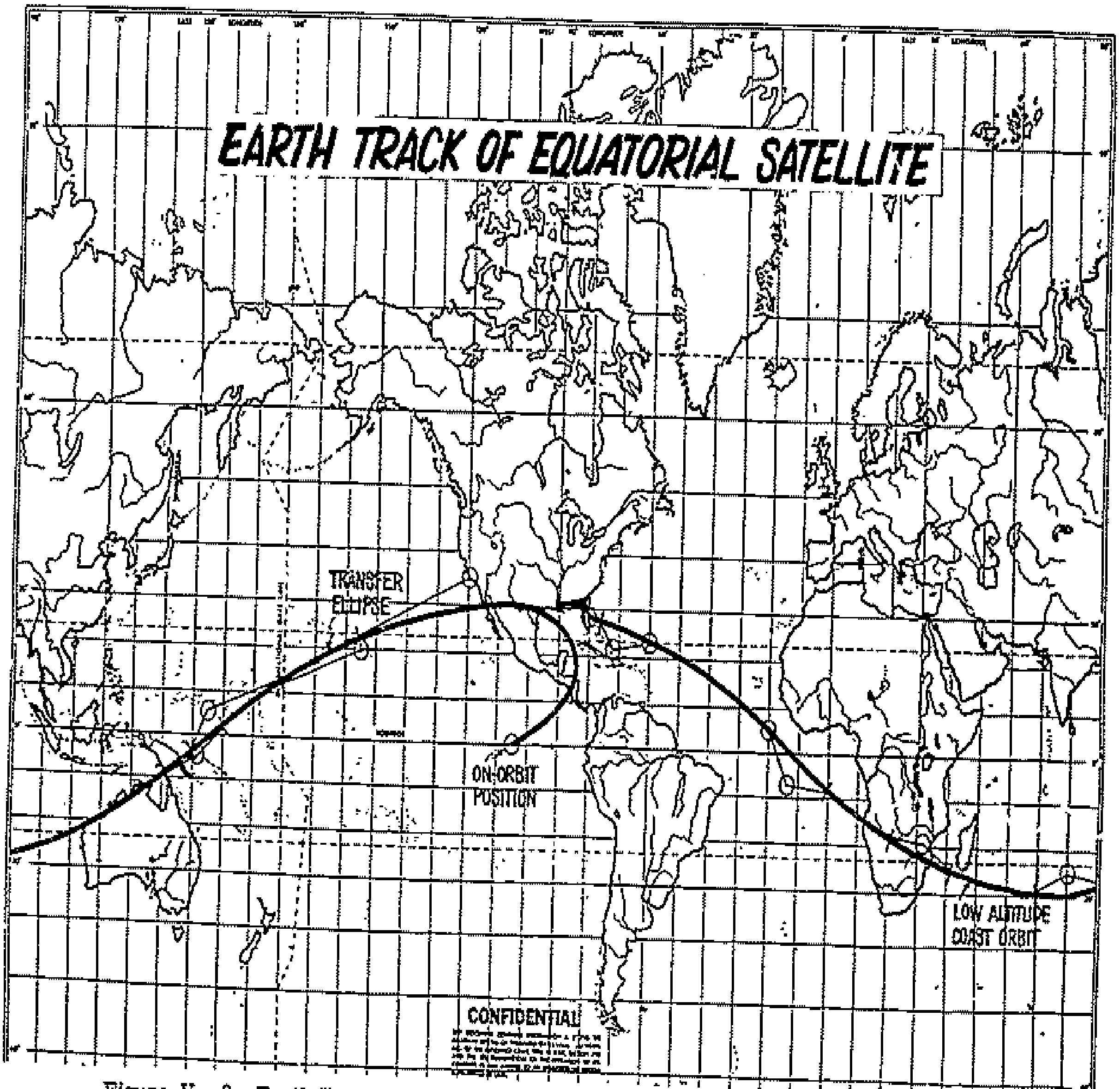

Figure V - 9. Earth Track of ADVENT satellite in 24-hour synchronous orbit by direct injection.

East longitude with a velocity deficiency from a 100 nautical mile parking orbit on the first equatorial (southerly crossing) of the equator. The satellite will then drift eastwardly to the desired longitude of 105 degrees West in a few days time. During the drift period, the velocity deficiency will be removed and the 24-hour circular synchronous orbit at a 19,300 nautical mile altitude will be established by velocity increments being supplied by a hot gas propulsion system in the satellite (Final Stage Vehicle). See Figure V-10. This latter method permits the placement of the satellite at any desired longitude over the equator around the earth. Three such equally spaced satellites would provide world-wide coverage in an operational situation. See Figure V-11.

d. Satellite (Final Stage Vehicle)

ADVENT satellite (Final Stage Vehicle)

While the exact dimensions of the payload are yet to be determined, one configuration under consideration is a rectangular structure 67" X 60" X 30" to house the net payload. This is exclusive of the antennas and solar paddles which will be mounted externally to the basic structure. See Figure V-12. The entire satellite will consist of five basic subsystems: (1) communications, (2) telemetry, tracking and command, (3) orbit and altitude control, (4) power supply, and (5) temperature control. The satellite will weigh approximately 1,200 pounds. The microwave communications subsystem will have four separate radio frequency channels, each with a band width of ten megacycles and each capable of providing twelve voice channels of communication or about 500,000 bits of teletype traffic (10,000 words) per second. This capacity is instantly available for use between any surface communication facilities within line of sight of the satellite and equipped to operate with it.

e. Ground Stations

Two fixed surface and one mobile surface ground stations.

Two ground communication stations located on the East and West Coasts of the United States respectively and one instrumented Naval surface vessel will be used in demonstrating the feasibility of the ADVENT concept.

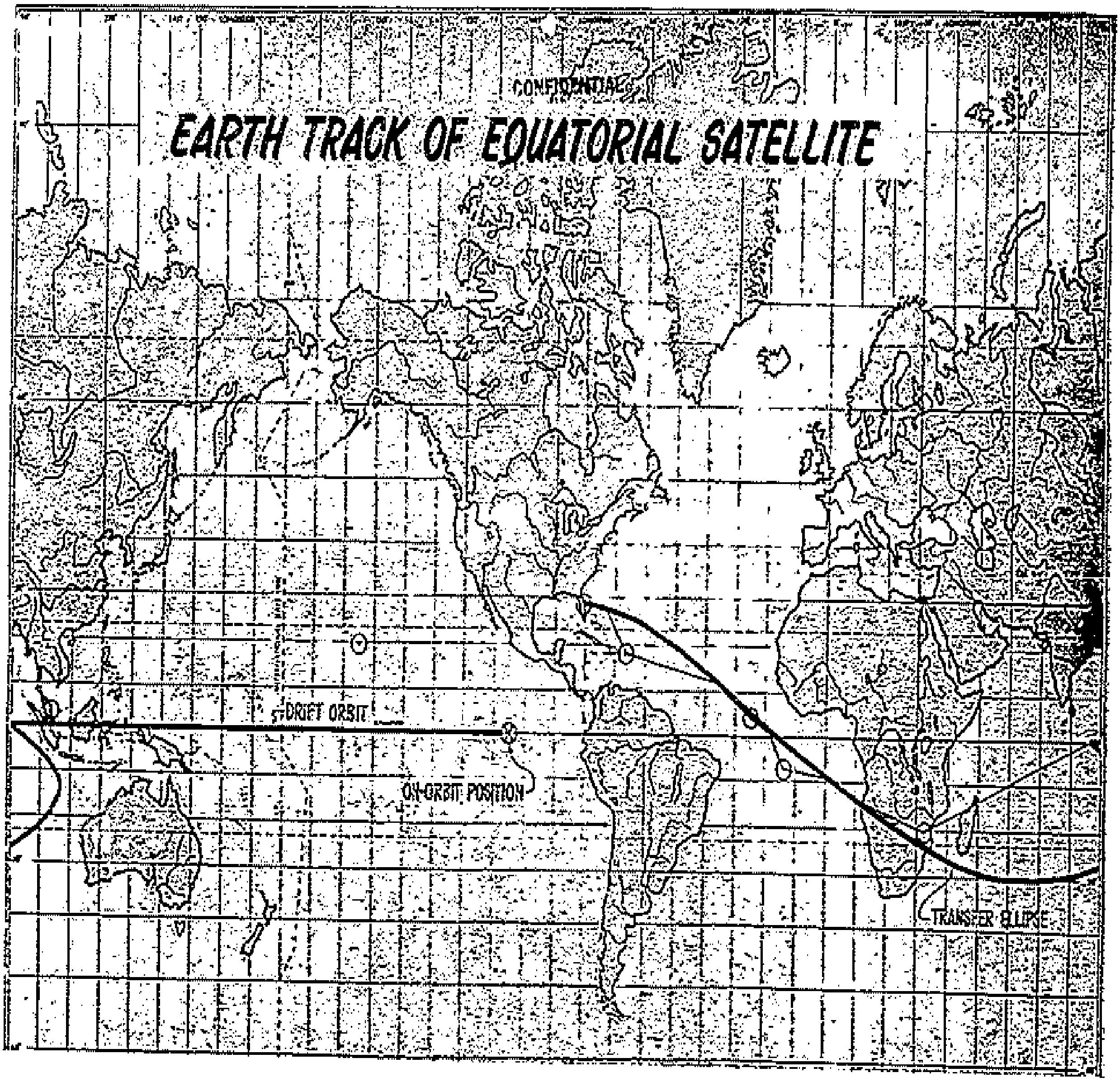

Figure V - 10. Earth Track of ADVENT satellite in 24-hour synchronous orbit by drift (walking) injection.

Figure V-10

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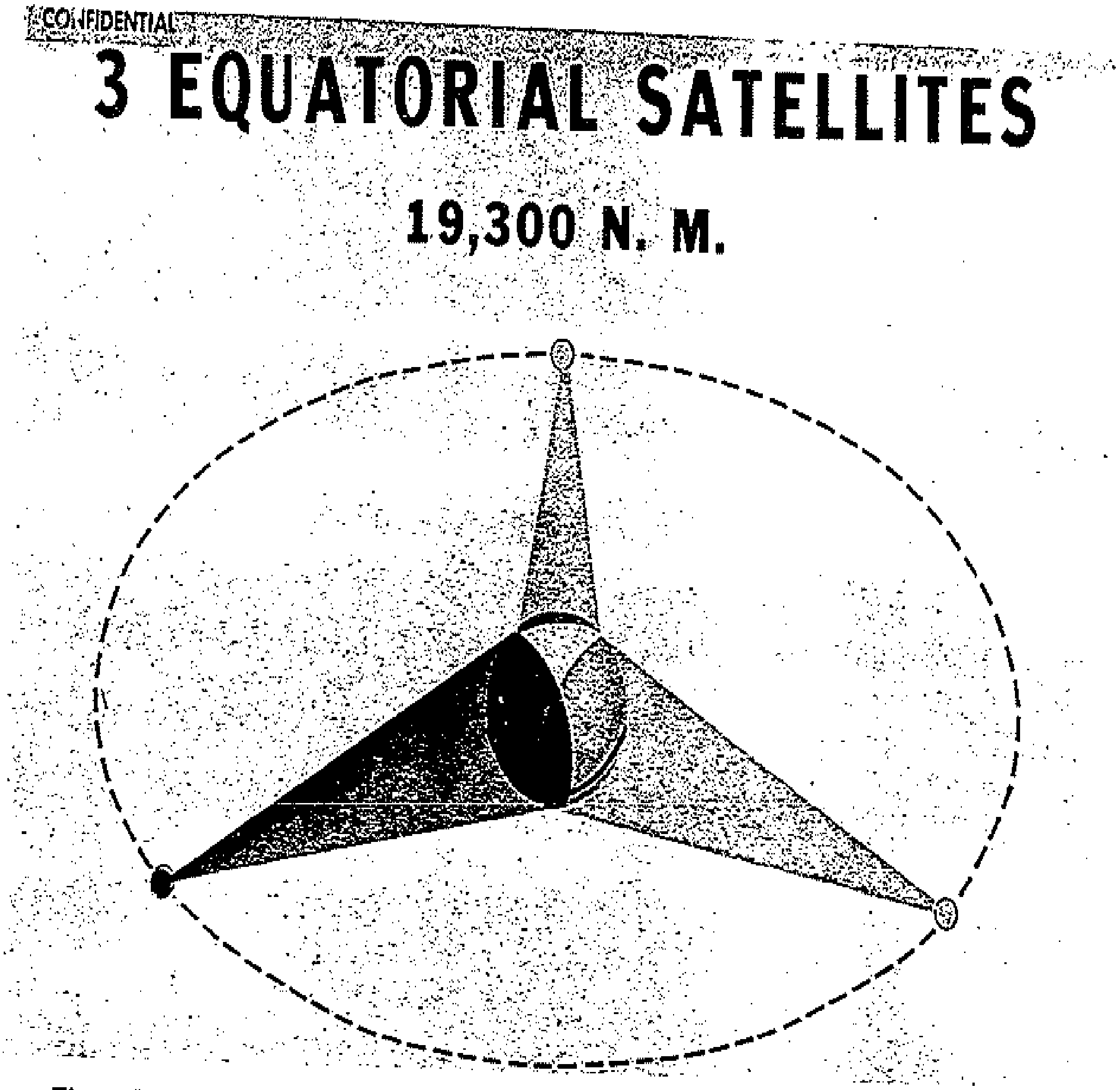

Figure V - 11. Schematic of ADVENT world-wide, except for polar regions, communications coverage by three equatorial satellites.

Figure V-11

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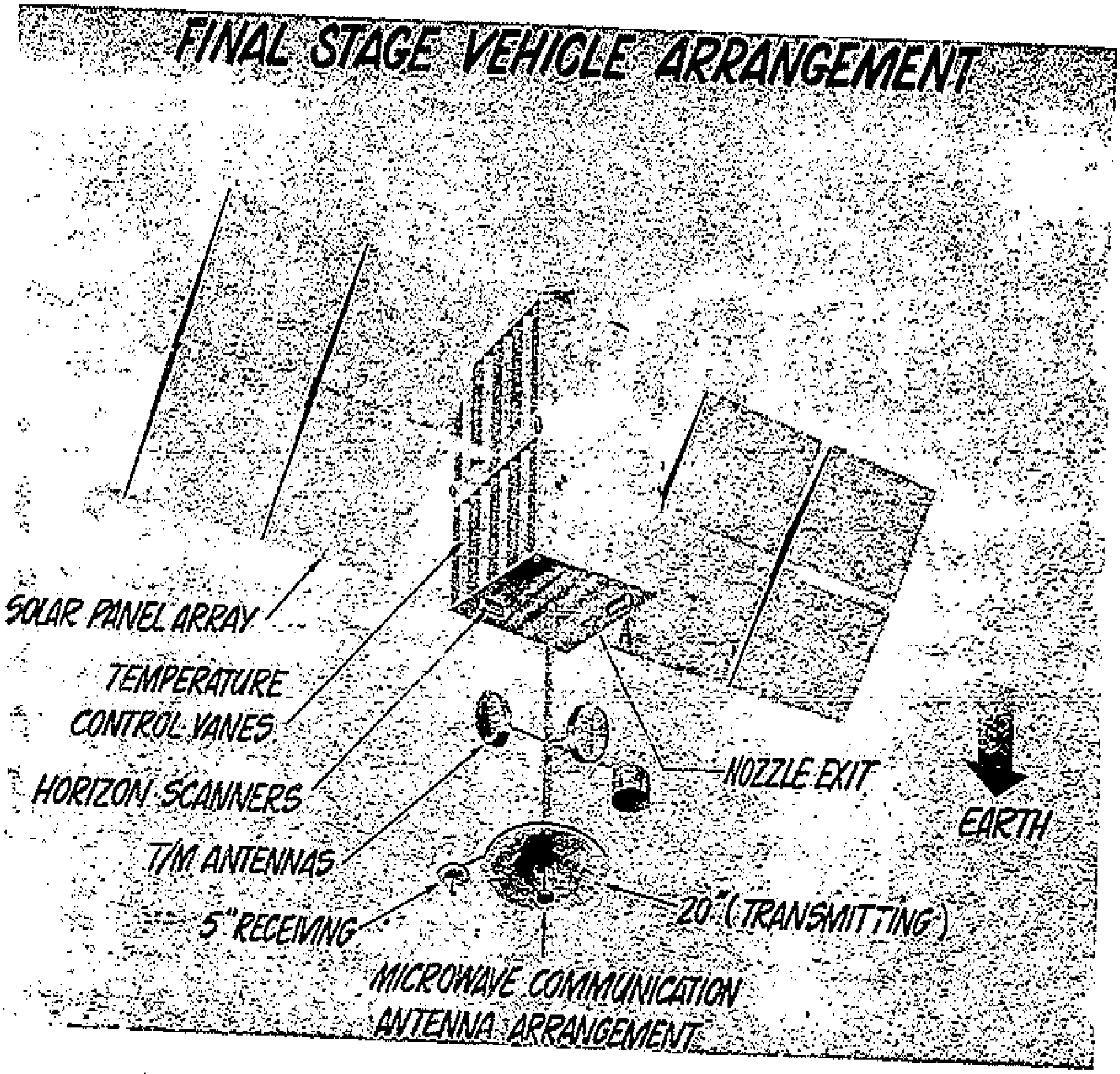

Figure V - 12. Concept of ADVENT final-stage vehicle configuration.

Figure V-12

VI. SHEPHERD PROJECT

(TRACKING NETWORK)

A. Project Objective

Project Objectives - Establishment of a space surveillance system to detect and identify space objects.

The objective of the SHEPHERD Tracking Network Project is the establishment of a space vehicle surveillance system that will detect and identify space objects both foreign and domestic. The system must also have the capability for orbit determination and prediction of future position of space objects and maintain a catalog of this information for users in the intelligence and defense fields.

B. Project Description

1. General

SHEPHERD comprises sensor elements and a control center.

a. The initial system developed for the Advanced Research Projects Agency (ARPA) comprises sensor elements for detecting nonradiating objects in near outer space and a data collection and satellite cataloging center. The principal sensor of the system is the space surveillance (SPASUR) detection fence developed by the Navy. This is located on an east-west line at about 32 degrees latitude in the United States. This fence presently comprises two complexes, one in the east and one in the west each with coverage of 400 miles in altitude and 300 miles in width as shown in Figure VI-1. Each complex consists of a centrally located transmitter station and two remote receiver stations along the east-west line. Each station of the complex has an appearance similar to the one shown in Figure VI-2.

Two surveillance areas exist at present.

DOPLOC project terminated.

b. The gap between the present two complexes was to have been filled by a DOPLOC system, based on the Doppler shift observed in radio signals from artificial earth satellites, a different technical approach from the SPASUR system. The DOPLOC project has been terminated as a result of a determination that it would not meet the immediate objectives of the program as early as the SPASUR system.

A 500 KW transmitter will fill the present detection gap.

c. A centrally located 500 KW transmitter has been authorized that will fill the detection gap between the present two complexes and provide space surveillance coverage over an area 1,500 miles in altitude and 2,000 miles in width. This will assure

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SPASUR COVERAGE

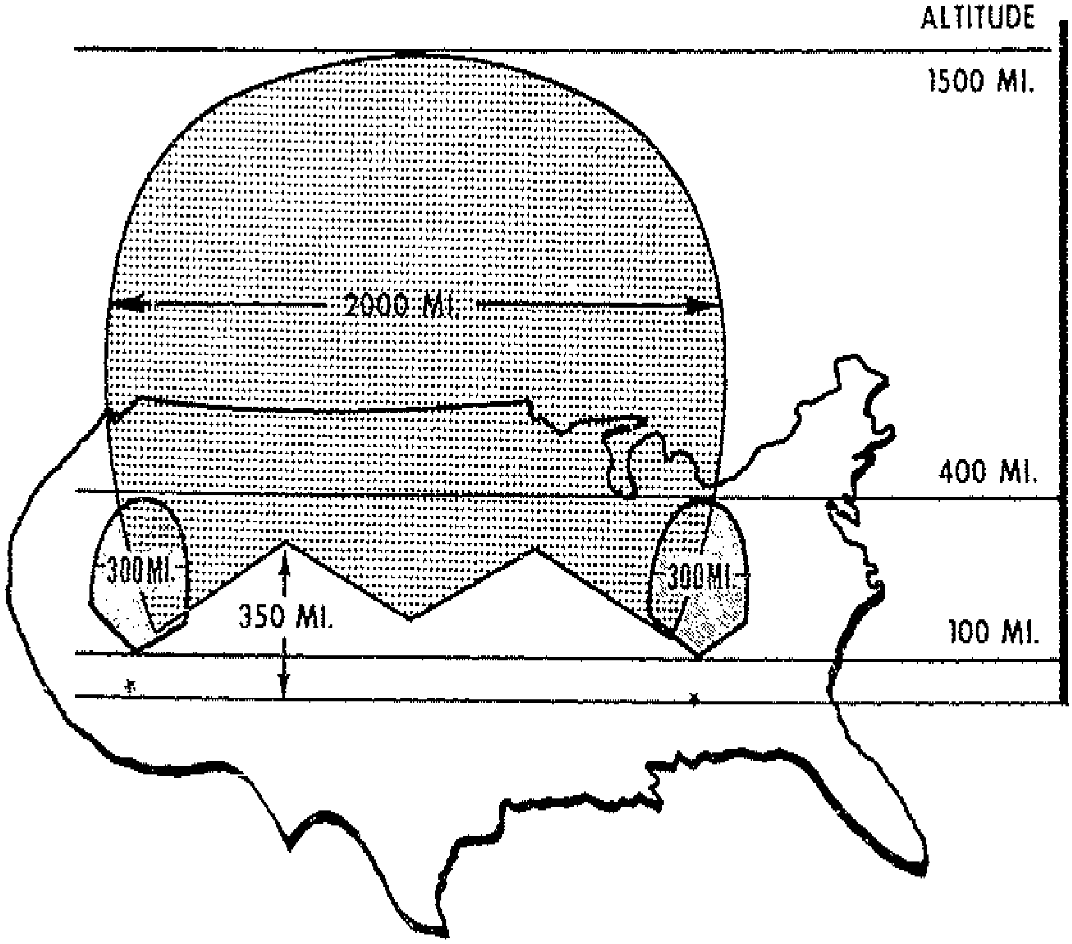

Figure VI-1. The space surveillance (SPASUR) system to detect, monitor, and collect data on all satellite objects passing over the United States.

Present coverage - The two shaded areas 400 miles high and 300 miles wide.

Planned coverage - The additional shaded area 1,500 miles high and 2,000 miles wide.

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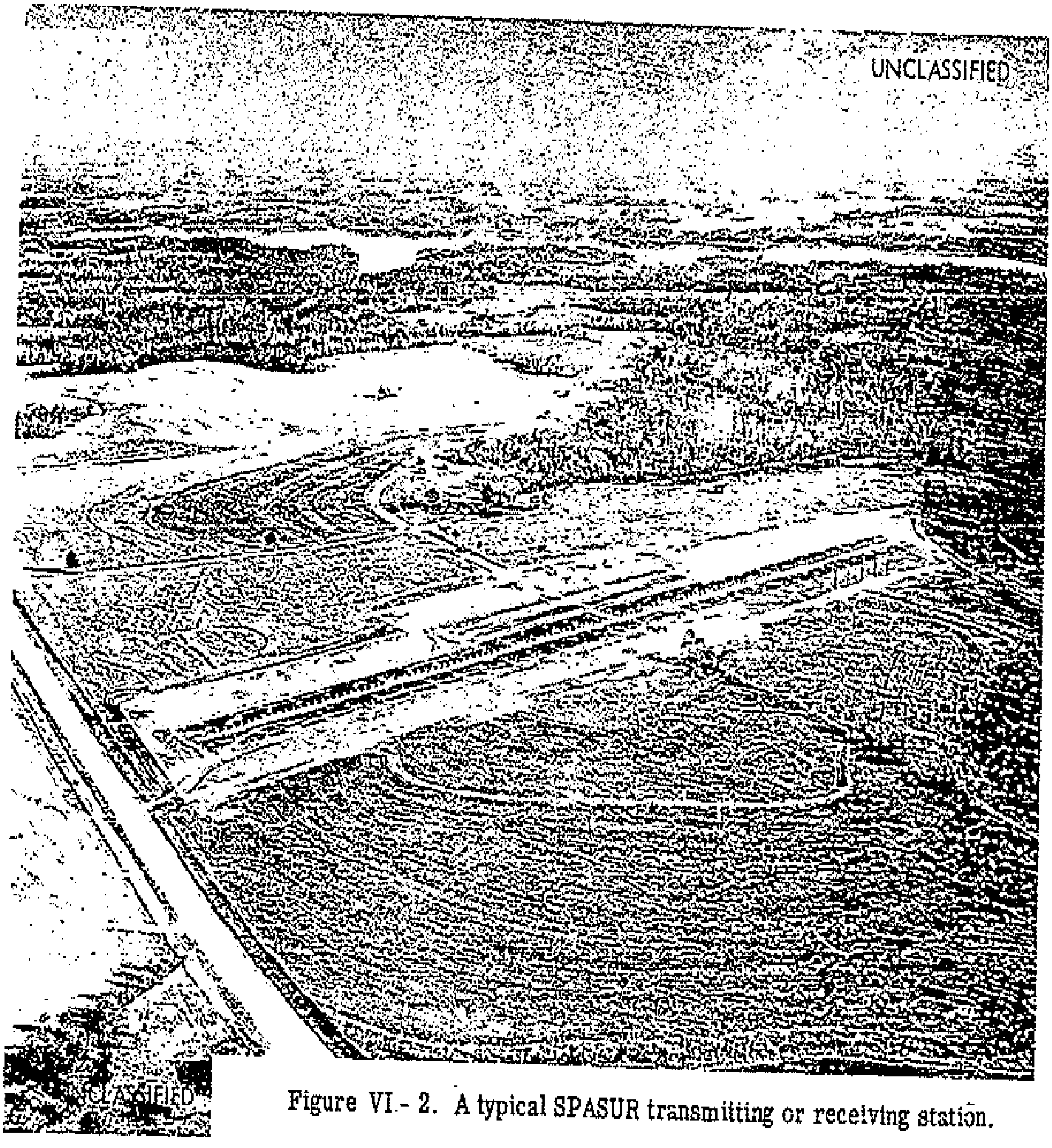

Figure VI.- 2. A typical SPASUR transmitting or receiving station.

a high probability of detection of any satellite within that area on its first pass over the United States.

2. Other Sensor Data

Sensor data are provided by sources other than SPASUR.

Sensor data relating to space objects are provided from other sources, such as the National Aeronautics and Space Administration (NASA) tracking stations, the Army, Navy, and Air Force missile ranges, and radar sites, such as the Ballistic Missile Early Warning System (BMEWS) and research and development centers.

3. National Space Surveillance Control Center

Control Center processes data, computes orbits, catalogs and issues position predictions of all space objects.

Information from the SPASUR system and all other sources is transmitted to the Air Force developed Interim National Space Surveillance Control Center (SPACETRACK) located at Bedford, Massachusetts. This center collates the data received, computes space vehicle orbits, catalogs the space vehicles and issues orbital position predictions. See Figure VI-3. This development has resulted in the recommendation for completion of a permanent National Space Surveillance Control Center.

4. Development of Improved Tracking Antennas

Development of improved tracking antennas.

A Department of Defense contribution to electronic subsystems development has resulted in the construction of two 40-foot tracking antennas with a configuration shown in Figure VI-4. These are in the final stages of construction with delivery scheduled for this fall.

5. Operational and Management Responsibility

Assignment of responsibility is under study.

A study is being made by the Department of Defense as to the appropriate assignment of operational and management responsibility to the military services for (1) the ARPA developed satellite detection fence (SPASUR) and (2) the National Space Surveillance Control Center (SPACETRACK).

C. Progress Review - March, April, May 1960

SPASUR system is in continuous operation.

1. During the reporting period, the space surveillance (SPASUR) system operated continuously and successfully acquired, observed, monitored and

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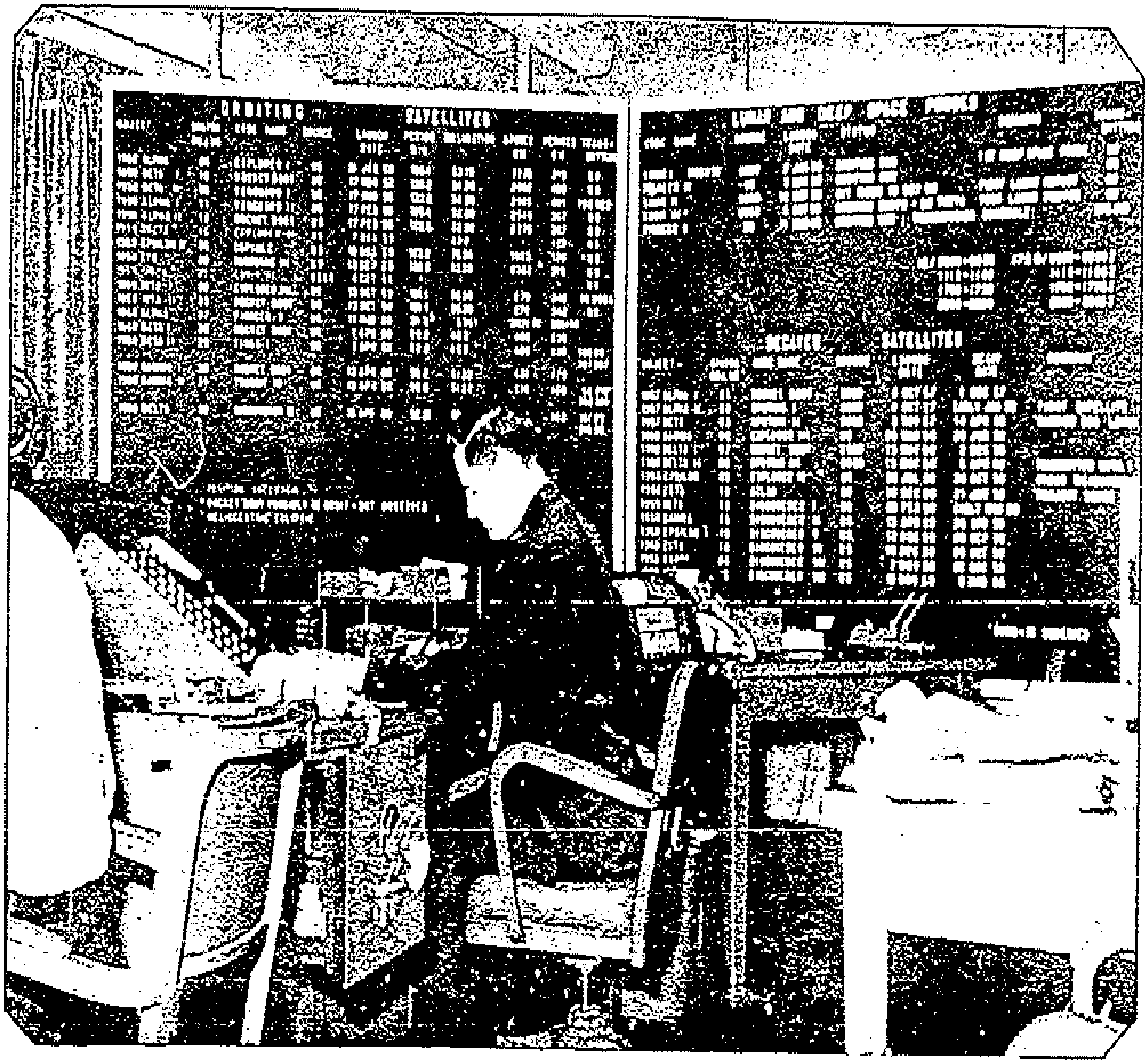

Figure VI-3. The control room equipment and status boards which form the nerve center of the National Space Surveillance Control Center (SPACETRACK) at Bedford, Massachusetts.

Figure VI-4. A transportable 40-foot tracking antenna test installation near Dallas, Texas.

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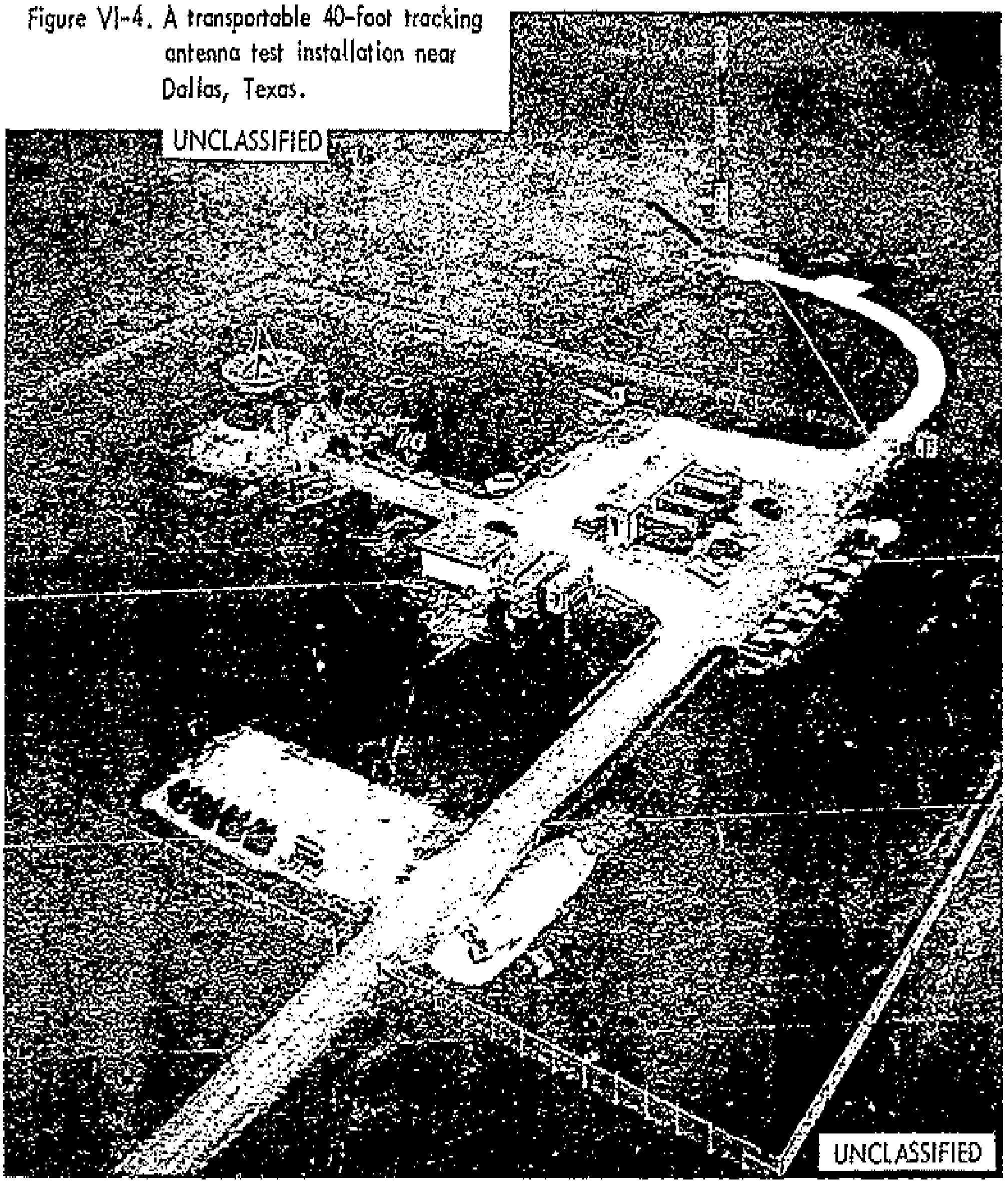

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collected data on all earth satellites within its range. The National Space Surveillance Control Center collated the data collected, computed satellite orbits, issued orbital predictions and catalogued all space objects reported.

SPASUR system detected change in orbit of SPUTNIK IV.

2. Noteworthy among the satellite observations made by the system was the initial orbital calculations of the Soviet Union launched SPUTNIK IV on 15 May 1960. On 18 May, the SPASUR network confirmed that an attempt had been made to change its orbit so that the payload would re-enter the earth's atmosphere. Because of some malfunction, an increment of velocity was added instead of subtracted and a changed orbit was effected. Currently, eight pieces of the original SPUTNIK IV are now in orbit. All of these objects have been tracked by the space surveillance network.

Tracking antenna was tested by tracking the moon.

3. As a part of the checkout program for the 40-foot tracking antenna stations, one of them was used to automatically lock-on and track the moon during the month of May 1960. Radio frequency illumination for these tests was provided by a transmitter located in Cedar Rapids, Iowa.

VII. STATUS OF FUNDS BY PROJECTS

(In Millions)

31 May 1960

Project	Funding FY 1959 and Prior Years	Amounts Programmed FY 1960	Cumulative Obligations	Cumulative Expenditures
DISCOVERER 1/ (R&D Satellites)	$ 136.6	$ 88.9	$ 212.7	$ 179.1
SAMOS 1/ (Reconnaissance Satellites)				
MIDAS 1/ (Early Warning Satellites)	22.8	58.6	67.1	47.7
TRANSIT (Navigation Satellites)	10.6	16.8	21.7	13.5
NOTUS (COURIER/ADVENT) (Communications Satellites)	16.7	20.9	30.9	16.9
SHEPHERD (Tracking Network)	31.8	12.9	31.8	20.8

1/ Excludes $85.7 million programmed during FY 1958 and prior years for WS 117L program. DISCOVERER, SAMOS and MIDAS projects are outgrowths of WS 117L.

PORTIONS EXEMPTED
E.O. 12065, Sec. 1-301 (c)(e)
10/5/79
NLE Date 10/29/79

SPACE VEHICLE LAUNCH SCHEDULE

As of 1 August 1960

Department of Defense Schedule with the National Aeronautics and Space Administration Schedule added for information.

		PROGRAM	VEHICLE	RANGE	1960					1961												1962												1963											
					A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
DOD	1	DISCOVERER	THOR-AGENA	PMR V	2	2	2	2	1	1	1	1	2	2	2	2																													
	2	SAMOS (RAD)																																											
	3	MIDAS (RAD)	ATLAS-AGENA	PMR Arg							1		1		1				1			1	1			1	1																		
	4	NOTUS (COURIER)	THOR-EPSILON	AMR	1		1																																						
	5	NOTUS (ADVENT)	ATLAS-AGENA	AMR																				1			1			1															
	6	NOTUS (ADVENT)	ATLAS-CENTAUR	AMR																																1		1		1		1		1	
	7	TRANSIT I, II	THOR-EPSILON	AMR				1		1*																																			
NASA	8	SATURN	Stage I	AMR												1						1						1																	
			Stage I & IV	AMR																													1			1			1						
			Complete-PAD	AMR																																					1		1		1
	9	CENTAUR	ATLAS-CENTAUR	AMR											1			1			1		1		1		1		1*		1*		1*		1*		1*				1*				1*
	10	MERCURY	REDSTONE (Suborb)	AMR		1	1		1	1		1	1		1	1																													
	11	MERCURY	ATLAS (Suborb)	AMR		1																																							
	12	MERCURY	ATLAS (Orbital)	AMR			1***		1***	1		1		1	1		1		1		1		1				1			1															
	13	LUNAR ORBIT	ATLAS-ABLE	AMR	1			1																																					
	14	AGENA-B	THOR-AGENA	PMR V																1				1				1				1				1			1				1		
	15	AGENA-B	ATLAS-AGENA	AMR												1			1			1			1			1						1							1				
				PMR Arg																																	1								
	16	DELTA	THOR-DELTA	AMR	1		1		1		1	1	1		1		1		1		1		1																						
	17	SCOUT	SCOUT	W. Is.		1		1		1			1			1		1			1											1*			1*			1*		1*					
				PMR-Arg																			1			1*			1*							1*									
	18	JUNO II	JUNO II	AMR			1		1			1		1																															

*Proposed b-backup
**Underlined numbers are AGENA -B Versions
***Orbital Abort Mission
****Subject to budgetary decisions FY '61 & beyond.
+ = DOD Payload

AMR-Atlantic Missile Range
PMR-Pacific Missile Range
Arg-Pt. Arguello, Calif.
V-Vandenberg AFB, Calif.
W.Is.-Wallops Island, Va. (NASA)

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